# CHEMICAL & METALLURGICAL ENGINEERING

VOLUME FORTY-THREE NUMBER ONE

## JANUARY, 1936




## NEXT MONTH

**"Chem. & Met.'s" 13th Annual Review Number**

TECHNOLOGY makes way for economics next month when *Chem. & Met.* editors and contributors present their annual parade of production statistics, distribution charts, market trends and editorial forecasts. This year, with more time for preparation, they should be bigger and better than ever before.

BUT the parade isn't the whole show. Half the pages in the big issue next month will tell a story that's of interest to every chemical engineer and executive in the process industries: "The Life Cycle of a New Product"—editorial theme song—traces the growth from the embryonic development of the new idea through the various stages of research and development into commercial production and on into competition and eventual displacement by still newer products. Here are some of the articles scheduled for the February *Chem. & Met.*:

"The Chemical Engineer's Rôle in America's Future." By Dr. Clifford C. Furnas of Yale, author of "The Next Hundred Years."

"Man Location—Neglected Science." By Dr. John H. Perry of Grasselli, editor of "Chemical Engineer's Handbook."

"Fifty Years of New Product Development." By H. V. Churchill, chief chemist of the Aluminum Company of America.

"Sales Development in Chemical Industry." By Chaplin Tyler of duPont, author of "Chemical Engineering Economics."

"Economic Feasibility Studies—First Step in the Sound Development of New Products." By a well-known chemical engineering authority.

"Present Day Procedure in New Product Publicity." By W. A. Hamor, assistant director of Mellon Institute.

"Who Should be Responsible for New Products?" By O. C. Holleran, market research specialist, U. S. Department of Commerce.

"Steps in the Introduction and Development of New Products in the Process Industries." A special 8-page wall-chart with appropriate check lists prepared by *Chem. & Met.* editors in collaboration with O. C. Holleran.

Only a limited number of extra copies of this issue and wall-chart are to be printed. The price including the editorial supplement will be $1 per copy. Place your order early for the

**February—"Chem. & Met."**
**13th Annual Review and Progress Number**




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# CHEMICAL
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# ENGINEERING

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S. D. KIRKPATRICK, Editor

JANUARY, 1936


## QUALITY—THE CRITERION FOR 1936

BEFORE Johns Hopkins University adopted its unique national fellowship plan of selecting and training potential leaders in chemical science and industry, a questionnaire was sent to the presidents of a hundred large corporations. But one question was asked: "In your opinion, do we need more chemists or better chemists to carry on the work of American industry?" Despite the fact that this was in 1928 when there was an actual shortage of technical men, 77 of the 78 replies stressed the greater need for better trained personnel.

The application of the quality criterion to personnel has its obvious bearing on the character of instruction in our schools and colleges, but it also has a less obvious application to other problems which the profession must shortly face. For example, the rapidly mounting accumulation of chemical literature has created a situation which is of serious concern to those charged with abstracting and cataloging the multiplicity of journal articles and patent references. They feel it is high time for a more critical function to be applied somewhere along the line. Midgley reminds us that a stagnation of science occurred in Ancient Egypt at a time when the libraries were so crammed with the accumulated but unclassified knowledge of the centuries that it would have required most of a life-time merely to search through the thousands on thousands of papyrus rolls. Little or no time was left for creative work.

Fortunately today we have the advantages of adequate indexing and cataloging which were denied the Egyptians, but it is possible that these in themselves are not sufficient to overcome the tremendous mass action of the literature producers. Witness the increasing size and cost of the annual and decennial indexes of *Chemical Abstracts*. No one wishes to see that important work curtailed, yet some arithmetically minded chemists are already beginning to wonder where the money is coming from to pay for it—if not in 1936, say, a few years or decades hence.

The answer gets back to the individual chemist or engineer and his relations to his scientific or professional societies. William L. Batt, president of A.S.M.E., has recently said that the time has definitely passed when a man should measure the value of his engineering society in terms of the number of pounds of publications he receives. Not all in the chemical profession can see eye-to-eye with the mechanical engineer in this regard but one is indeed blind if he fails to recognize a gradual trend in that direction.

The time is coming when convention programs will no longer carry the titles of hundreds of incomplete and inconsequential papers, apparently presented primarily for the purpose of aiding and abetting the promotion of assistant professors to associate professors. Some place, someone will start to apply the critical function and fewer but better papers will result. Further along the line the same process applied even more vigorously will limit the number to be published *in extenso* in the journals. And the final and most careful selection will come in their critical interpretation and correlation with existing knowledge.

Quality is the criterion most commonly applied to the manufactured products of chemical industry. Does it not also have equal application to some of the current problems of the chemical profession?

# From an EDITORIAL Viewpoint

### Caution Needed Amidst Commotion

ELECTION years are proverbially disturbing to business. And a Congressional session with the multitude of problems before it will often have a like effect. Industrial executives are, therefore, confronted with two jitters-generating possibilities. It will be a real test of the emotional stability of business men to face the very serious legislative problems now being confronted. But it is in order to distinguish between these and the mere noise of a loosely geared political mechanism. Calm amidst commotion will be an important virtue in industrial circles this year.

### Trust Busting Still In Fashion

COMPETITION must be served. Collaboration and cooperation of industrial executives leading toward price control remains taboo in Washington. The Federal Trade Commission is just as aggressive, perhaps more aggressive than in recent years, in its effort to prevent any such collusion as may amount to restraint of trade.

There is very real competition in the marketing of most chemicals and of most other products of the process industries. Buyers as well as sellers of these industries well know this. It is not so certain that Federal officials all believe it. Hence it is today just as important as ever that there be given to the Commission, and to the Department of Justice, no opportunity for confusing proper industrial cooperation with those illegal types of "conspiracy" which are constantly being sought out for eradication.

### Census Questions Deserve Prompt Answers

QUESTIONNAIRES are going to be annoyingly numerous during January and February. Uncle Sam is census taking again. But industrial executives should not be unduly annoyed. They should, rather, attempt to cooperate in order that the results of inquiries may be promptly had for use in further business planning.

This year we are to have not only the customary census of manufacturers but also a census of mines and quarries, a census of business, and several other compilations. Not all of the efforts being made will lead to useful data, but the Department of Commerce is sincere in its objective, to serve, not to annoy. Most of the results will be constructive and valuable guideposts to further programming by industrial management. The value of what we get will depend very much on the promptness with which results are reported. Hence those who want results, as most of us do, should return the questionnaires filled out as completely and promptly as possible.

### On Taking "Time to Think"

ONE EXECUTIVE whose chemical company employs hundreds of chemists and chemical engineers reports that he considers himself fortunate if after a few years he can pick two really good men out of every ten he has employed. The others remain in the organization, to be sure, but he said that they were usually "unable to emerge from their work as technicians into positions of larger responsibilities." Asked what was the discriminating criterion, the executive replied, "I am inclined to pick those who find a place for themselves in the company's balance sheet—the arithmetically-minded, so to speak."

The emphasis on economics is important and undoubtedly warranted, but at the moment we are more concerned with the problems of the eight men "unable to emerge from their work as technicians." Is it the system under which these men work, or are they themselves at fault? We decided to do a little investigating. We found that most of the men were employed at fairly good salaries, with pleasant and congenial working conditions. The company was on a five-day week at the time, yet the most of these men were spending 5½ or 6 days on the job. Several hadn't had vacations of more than a few days in years. Why? Because, we were told, that they were "too busy," with too much important work that could not be dropped or turned over to others.

Perhaps that was true, but it made us wonder whether or not this had anything to do with the fact that only two of the original ten were picked for the bigger jobs ahead. The eight thought themselves too deeply involved in their immediate work as technicians to take on these larger responsibilities. Undoubtedly they were, but we'd be inclined to question the fairness of that involvement to the men themselves and to their employers.

James H. McGraw, Sr., retiring this month from the chairmanship of his company after more than fifty years in the publishing business, gave his executives and editors this advice: "Take time to think. Dream a little. Spend a little while each day looking out the window,—and into your own problems as well as those

of the company. The best advice I can leave with you is in those two familiar lines of Browning: 'Man's reach his grasp must exceed, Else what's a Heaven for?' "

That sort of advice might not be out of place in the curriculum of chemical engineering in some of our schools and colleges. It might even help to raise the average to at least three out of ten.

## Pittsburghers Point with Pride

GOLDEN jubilees are becoming the order of the day in Pittsburgh. On January 8 that city was the center of a unique celebration in which branch offices of Westinghouse all over the world were linked together by radio to exchange greetings and hear talks by Board Chairman A. W. Robertson and President F. A. Merrick. More than 40,000 employees in 80 different countries cheered and were cheered by the news of better business in the heavy industries, coincident with Westinghouse's fiftieth birthday.

February 23, 1936, will mark another historic anniversary of particular interest to Pittsburghers. It will be the fiftieth since that day when young Charles M. Hall came out of the family woodshed in Oberlin, Ohio, shouting, "Eureka, I have it!"—and proudly exhibiting the first pellets of metallic aluminum ever made by the now famous Hall process. Appropriate plans for this celebration will doubtless be announced shortly.

What these two great companies have contributed not only to Pittsburgh but to the chemical, electrochemical and metallurgical industries of the world is a record of outstanding achievement. Our congratulations to both!

## Misnomer Shows Loose Thinking

INCOME is produced by various types of human activity. But it is absurd to refer to governmental disbursements as "income produced." Nevertheless, a recent Department of Commerce document does just this.

Of the national income of 1934, which amounted to $48 billion, this report shows that 17.3 per cent was from governmental disbursement. In other words, nearly one-fifth of the total available for spending from current income was the result of work relief or other governmental activity. And, unfortunately, a large share of this percentage was merely artificial spending by Federal agencies.

Official interpretations of fundamental economic facts should be more reliable. It is a gross distortion to call this kind of spending "income," or to think of it as being "produced." Much bad adminisration can originate in this kind of illogic. One does not need to oppose work relief in order to justify criticism of this kind of misinterpretation. The disbursement may be justified, but the bad reasoning never can be.

# TRENDS That Will Be Important IN 1936

**Technology and Economics will be inseparable companions of the chemical engineer as he faces the important problems that lie ahead in 1936. Every technological improvement in product or process will turn on a careful balancing of economic factors. Every major economic trend in an industry will likely affect its technology. Future chemical engineering plans must take both technology and economics into consideration. With this in mind, the editors of "Chem. & Met." present in this January issue a unique series of articles that deal with recent and important trends of technology in four major process industries—paint and varnish, petroleum refining, gas and fluid fuel and the metallurgical fields of most interest to chemical engineers. Next month the February issue is to be the thirteenth in the series of "Chem. & Met. Annual Review and Progress Numbers." Then, Economics will be the order of the day as production and consumption statistics, market studies and important industrial trends are passed in review. The Parade of Progress marches on!**

Volume 43—**Chemical & Metallurgical Engineering**—Number 1

*Chemical & Metallurgical Engineering* is the successor to *Metallurgical & Chemical Engineering*, which in turn was a consolidation of *Electrochemical & Metallurgical Industry* and *Iron & Steel Magazine*, effected in July, 1906.

The magazine was originally founded as *Electrochemical Industry*, in September, 1902, and was published monthly under the editorial direction of Dr. E. F. Roeber. It continued under that title until January, 1905, when it was changed to *Electrochemical & Metallurgical Industry*. In July, 1906, the consolidation was made with *Iron & Steel Magazine*, which had been founded eight years previously by Dr. Albert Sauveur. In January, 1910, the title was changed to *Metallurgical & Chemical Engineering*, and semi-monthly publication was begun Sept. 1, 1915. On July 1, 1918, the present title was assumed and weekly publication was begun Oct. 1, 1919. Monthly publication was resumed in March, 1925.

Dr. E. F. Roeber was editor of the paper from the time it was founded until his death on Oct. 17, 1917. After a brief interim he was succeeded by H. C. Parmelee. Ten years later, Nov. 1, 1928, Mr. Parmelee was elected vice-president of the McGraw-Hill Publishing Company and was succeeded in the editorship by Sidney D. Kirkpatrick.

The editorial staff of the magazine comprises: S. D. Kirkpatrick, editor; James A. Lee, managing editor; H. M. Batters, market editor; T. R. Olive, associate editor and R. S. McBride and Paul D. V. Manning, special editorial representatives in Washington, D. C., and on the Pacific Coast, respectively. 

Modern varnish fires using fuel oil and compressed air, and providing uniform distribution of heat through domes of refractory materials

# Trends in the Paint and

By WAYNE R. FULLER and M. S. ARMSTRONG

*Technical Director and Research Chemist, respectively*
*Pratt & Lambert, Inc.*
*Buffalo, N. Y.*

WITH more than 1,000 American chemists and chemical engineers working on paints, varnishes, lacquers, and their essential raw materials, progress is being made at a rate that taxes the capacity for comprehension of those who are in the thick of it. No less difficult is the task of condensing into an article of moderate length a discussion of the recent technical developments.

There is, perhaps, no other phase of paint technology that has aroused such widespread interest as the use of synthetic resins. This is the outstanding development of recent years. They were first introduced to the paint and varnish industry as rosin glyceride or ester gum. It proved to be a valuable adjunct to tung oil and remains one of the most largely used resins. But the present-day use of the term synthetic resin does not include ester gum within its meaning. And so the synthetic era might more properly be said to date from 1910 when Berend and Albert produced the first oil-soluble resin. This rosin modified phenolic resin, Albertol, was introduced in the United States about 1926. Its property of causing rapid gellation or setting of varnish led to the development of quick drying or four-hour varnishes and enamels.

By 1928, resin producers were successfully marketing products of higher phenol-formaldehyde content. These resins permitted development of quick drying varnishes and enamels of greatly improved exterior durability. A year later the oil-soluble, 100 per cent phenolic resins appeared. They were made possible by the availability of new types of phenols, the aromatic substituted phenols. Closely on the heels of these resins came another of the 100 per cent phenolic type containing the aliphatic substituted phenols. This variety possesses in only slightly reduced measure the outstanding qualities of the other 100 per cent phenolic resins—rapid drying, water and chemical resistance and exterior durability. It shows in addition practically no discoloration on exposure to light, and the tendency for exposed varnishes to fail by coarse cracking and scaling was considerably lessened.

In the phenol class the less spectacular and less publicized modified resins greatly exceed the 100 per cent resins, being employed in the majority of quick drying interior varnishes, four-hour enamels, quick drying floor varnishes, and many other industrial products. Modified resins of the Albertol type have kept pace with the resin industry and have been progressively improved in color, hardness, and general utility. In the modified resins of higher phenolic content improvement has paralleled that in the non-modified type, utilizing the same aliphatic substituted phenols.

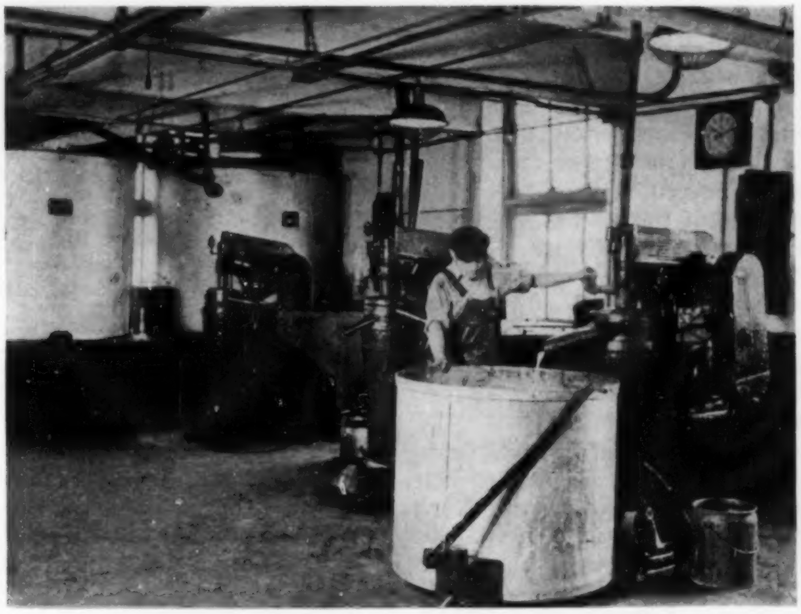
The alkyd resins arrived on the scene later than the phenolics and are today the chief center of interest. It was found that resins made with the fatty acids of non-drying oils made a valuable constituent for nitro-cellulose lacquer, serving the functions of both plasticizer and resin. They continue to be used for this purpose.

A step of major importance was the development of oxidizing or air-drying resins, by replacing acids of non-drying oils with those of the drying oils. It is resins of this type that are in widest use, both as a clear varnish, especially for exterior purposes, and as a vehicle in a variety of air drying and baking pigmented coatings. More recently a group of resins made with the fatty acids of semi-drying oils (soya, sunflower and rapeseed) have come into prominence for baking enamels. For convenience we have referred exclusively to the acids of various oils, but in practice the acids are frequently replaced partly or entirely by the oils themselves.

The alkyd resin class is further complicated by modifications with other resins as well as with oils. Combinations of alkyd and phenolic resins have attained some importance.

Next among the resins in apparent potentialities is the vinyl type. The American made resin has demonstrated such utility that present output is inadequate to supply the demand, even at higher prices than any other

# Varnish Industry . . . .



**Centrifugal clarifiers are used in the paint industry for black enamels as well as for clear varnishes. Clarifiers operating on black enamels**

resin in volume production. There has been greatest demand for the hardest of the three resins in the series, and its most extensive application has been for coating the interior of beer cans.

There are several other developments that are of interest. The two resin-like materials derived from rubber were introduced in 1932 by Goodyear Tire & Rubber Co. and Hercules Powder Co. Interest centers around their chemical resistance. Petroleum resins are recommended for cooked oil varnish, using mineral spirits as thinner. Cumarone-indene resins have been modified, necessitating a revaluation. Chlorinated diphenyl resins, mechanically processed copals and toluene sulphonamid-formaldehyde are other products having special applications.

Drying oils present a much simpler situation than synthetic resins. Synthetic drying oils that compete with the natural products in quality and price seem quite remote. In the main, we are using the same oils as we did 10 or 15 years ago and in about the same way, although economic factors and technical trends caused a change in the relative importance of the various oils.

Almost two-thirds of the drying oil consumed by the paint industry is linseed. If we consider only exterior and wall paints, the position of linseed oil is even more impressive, since tung oil, second in volume by a wide margin, is employed principally for varnishes and enamels. A new but expanding field for linseed has been opened by the use of linseed fatty acids in alkyd resins of the oxygen-convertible type.

A perennial subject of discussion in the industry is replacement of linseed by other oils to reduce cost or improve quality. The only oils of such quality and present availability as to merit serious attention are soya, perilla, fish and tung. Normally the first three are cheaper than linseed, while tung oil averages higher, fluctuates enormously in price, and the supply is somewhat uncertain. The 1934 consumption by the industry of the three cheaper oils combined was only 15 per cent of that of linseed, while tung oil was 43 per cent. For explanation we need only consider their properties.

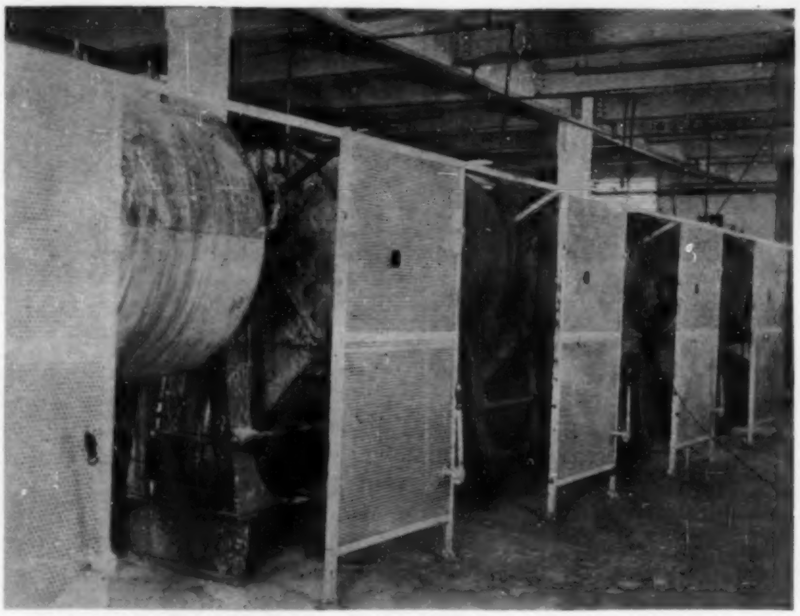
Greater use of soya oil in paints has been strongly advocated by various governmental bodies and agricultural groups. But it happens that soya is a semi-drying oil. In order to obtain drying and other properties similar to linseed oil it is necessary to use tung oil with it,

which raises the cost and creates various technical handicaps.

Perilla oil, from Manchuria, probably has greater technical possibilities than soya oil and the fact that it ranks slightly below soya in consumption is explained by the limited supply.

Fish oil, cheapest of the drying oils, has been developed in improved forms and is leading soya in volume. In 1932, according to the Department of Commerce, fish oil exceeded soya by only 1 per cent, but two years later the spread had increased to 11.5. While the price factor cannot be ignored, it has been reinforced by improved quality of fish oils and a greater variety of refined, bleached and processed oils.

The interest that naturally attaches to tung oil because of its unique and valuable properties has been intensified by the recent scarcity. To date, domestic production of this oil has been negligible in quantity. The quality is superior to imported oil, but under the system of inspection inaugurated by the Chinese Government some time ago imported oil is quite satisfactory in quality and uniformity.



**A battery of water-cooled pebble mills**

An aggressive search for substitutes for tung oil has been conducted by the American Paint, Varnish and Lacquer Association, through the Institute of Paint and Varnish Research. The most promising substitute is probably Brazilian oiticica oil, which was imported in small tonnage during the past year. Hopes aroused by early reports on this oil have been tempered as a result of more complete and practical investigations.

Pigment producers have been fully as active as resin producers in developing new products and countless modifications of established ones. These developments have contributed much to the progress of the paint industry and rank second only to those in the resin field.

Basic carbonate white lead has been made in finer particle size, producing greater hiding power, whiter color and heavier consistency. Lead-free, American processed zinc oxide has been developed in grades that have larger particle size and greater freedom from "fines," resulting in improved durability. The past few years have brought more general recognition of the merit of 35 per cent leaded zinc oxide for use in exterior paint formulations.

Zinc sulphide pigments have been the subject of extensive research, which has resulted in improved characteristics and a wider range of useful properties. This variety continues to lead the field of white pigments in tonnage consumed, mostly in interior products. Grades of lithopone have been added which are characterized by quick wettings and minimum settling, attained by treatment of the pigment with soaps of fatty acids. Through the development of high-strength lithopone on a base of anhydrous calcium sulphate and calcium carbonate novel properties have been obtained. Straight zinc sulphide also finds use as a paint pigment when great hiding power is desired.

The outstanding development in white pigments during the past few years has been the increasing rôle played by titanium pigments. The original titanium pigment was a composite pigment containing in admixture 25 per cent of the oxide and 75 per cent of blanc fixe. This is still the leading titanium pigment in point of volume. In 1925, titanium-calcium sulphate pigment (30 per cent $TiO_2$) and straight titanium oxide were introduced.

The titanium-blanc fixe pigment has been generally adopted as one of the components in high-grade exterior white house paints. Probably the majority of first-class multiple-pigment white paints include this pigment in quantities up to 40 per cent by weight of the total pigments. For wall paints and enamels and other interior products, the titanium-calcium sulphate pigment has proved more suitable than the titanium-blanc fixe pigment.

Antimony oxide has proved useful in the formulation of enamels of the alkyd resin type. It has proved to be the most suitable pigment for exterior purposes and is used either in conjunction with titanium oxide or alone when hiding permits. An antimony oxide of at least equal color to the English product is now produced in Texas.

**Extenders have lately been increased in utility** by the addition of three new materials. The first of these is a fine precipitated calcium carbonate, treated with oleic acid fumes to form a surface coating of calcium oleate. Two grades of diatomaceous earth have been prepared for the paint industry. Their most valuable property is high-flattening power, which is useful in wall paints for maximum flatness and in reducing gloss of enamels. The third new extender is a specially prepared mica advocated for exterior paints.

Lately, there has been relatively little significant development in the field of black pigments. Gas carbon blacks may be considered as standard for black enamels and black lacquers. In the latter a distinct improvement in intensity of color and in gloss has been achieved by

**A battery of six 5-roll steel mills**

cobalt. These new materials have better initial solubility than the older driers; in addition, the stable nature of the acid radicle eliminates the tendency to decrease in solubility on aging.

Another type of drier has been developed by the Resinous Products & Chemical Co. They are metal salts of a number of special saturated acids. One grade is competitive with the naphthenate driers, while another offers advantages over the naphthenate driers and is used in certain formulas.

More petroleum solvents than any other type are used, because they afford a wide range of useful properties at minimum cost. Mineral spirits, with an evaporation rate approximately that of turpentine, easily ranks first and for many purposes is as satisfactory as turpentine. Within the past few years petroleum refiners have made available fractions that more completely cover the evaporation rate requirements for various purposes.

The main development in terpene solvents has probably been the great extension in the use of dipentene, which has proved admirably adaptable to synthetic resin varnishes. Steam-distilled wood turpentine has been further improved in odor and is widely used.

dispersing the carbon black in nitrocellulose and plasticizer on heated steel rolls of the type used in compounding rubber. One of the carbon black manufacturers is offering such a product to the lacquer industry in the form of dry chips, which when dissolved in a suitable solvent mixture gives a finished lacquer.

Colored pigments present so many complexities that it is difficult to treat them briefly. The lead chromate yellows, with their range from primrose to deep orange, furnish the bulk of the yellow and orange pigments. In the field of blue pigments the paint and lacquer producer may take his choice between prussian blues and ultramarine blues, but both have grave defects. The chrome greens constitue the major part of the green pigments, but within the past few years guignet green has demonstrated true merit for certain purposes.

Red pigments have of late responded little to research. We still have the iron oxide pigments, natural and synthetic, for the duller reds, and toluidine toner, paranitraniline toner, lithol toner and fire red toner for the brighter reds. The only noteworthy innovation is the addition of cadmium-selenium reds.

Aluminum powder has been the subject of much discussion and has gained in favor as a paint pigment for certain purposes. It has proved helpful in the priming of exterior wood, and has proved unsurpassed as an exterior metal paint when applied over a primer containing rust inhibitive pigments.

Drier technology were practically stationary for several years prior to 1928 when the naphthenate driers appeared in this country. They met with hearty approval and are now probably employed by all paint and varnish producers, although the older driers have their field and continue in general use. In the naphthenate driers, as in the older types, the metals used are lead, manganese and

In the field of lacquer solvents a number of the well-established alcohols, esters and ketones are now being synthesized. And many new ethers and ketones have been added to the list.

There have been numerous minor advances affecting nitrocellulose and lacquer, together with a few special technical developments which aroused expectations that have not yet materialized. Nitrocellulose producers have been able to raise the stability test requirement in aircraft dopes from 25 to 35 minutes. About 1928, $\frac{1}{4}$ second cotton was put on the market and more recently a grade that is rated as $\frac{1}{16}$ second was offered.

Attempts to avoid payment of royalty by formulation of lacquer with viscosity characteristic of 5 seconds or higher have met with meager success. The most popular nitrocellulose is $\frac{1}{2}$ second and changing to 5 seconds means that the viscosity imparted by a given amount of nitrocellulose is increased tenfold. In order to maintain the non-volatile content at working consistency it is necessary to replace the nitrocellulose with resin, which involves sacrifice in one or more desirable properties.

In the automobile lacquer field the most radical change has been the adoption by some manufacturers of so-called "high solids" lacquer. The advantage is that only two-thirds as many coats are required for equal body on the work. And these manufacturers are now testing high solids lacquers in which flow has been improved.

Cellulose nitroacetate, which was made available only recently, resembles cellulose acetate in properties more closely than the nitrate. Among the advantages over nitrate are non-flammability and less yellowing. However, its use is greatly restricted by limited solubility and high cost.

Most revolutionary of the recent developments is water emulsion lacquers. The advantages claimed are:

low cost; resistance to blushing under high humidity; relative non-flammability, non-penetration of porous surfaces. The last named property may prove of greatest technical value, especially for coating paper, fabrics, etc. Lacquers of this type also possess a number of disadvantages, which have retarded exploitation on a large scale.

The largest equipment item in a paint and varnish plant is grinding machinery and it is here that the past few years have seen greatest improvement. Buhr stone mills, with their high maintenance cost, high labor cost and slow production, have been further replaced by other types of mills. In a modernly equipped paint factory their use is limited to the grinding of heavy materials, such as paste paints, oil colors, and perhaps a few very refractory earth pigments.

Steel roller mills continue to be the most widely used equipment for the grinding of fine enamel products. The conventional mill with three rolls is rapidly being replaced by four- or five-roll mills that give greater production, and in one grinding produce fineness equal to two grindings through the three-roll mill. Another development in roller mills is a single-roll mill in which a mixing hopper fits against the single roller and grinding is effected between the roller and a stationary bar. One modification of the mill has an oscillating roller and there may be two grinding bars instead of one. The latest form of this mill has provoked considerable interest in this country.

**Automatic filling and labeling machines prove economical for production items**

The original buhr stone lined pebble mill using flint pebbles is continuing an evolutionary process. For paint and lacquer products that are sensitive to heat the use of water-jacketed mills early came into vogue. To eliminate grit derived from lining and pebbles, porcelain lining and porcelain balls have been adopted for some classes of products. Color of finished product permitting, steel balls have been used in porcelain lined mills for greater efficiency. And where color is no object maximum efficiency has been obtained from a steel shell and steel balls. The latest design in mills of this type attempts to combine the most desirable features of all earlier mills. Both mill and balls are made of a hard chrome manganese steel, which reduces discoloration of the batch. Instead of the usual bars for lifting the balls, bulbous streamlined enlargements are formed at intervals around the periphery and extend horizontally for the full length of the mill. The object is elimination of sharp projections for the balls to abrade. Smaller balls than has been common practice are used for greater grinding surface.

Mills that are new to the paint industry have been borrowed from other industries and modified as necessary. The best example of this is the banbury mixer, long used in the plastic and rubber industries. It was found that a two-roll steel mill of the type used for milling rubber would produce black lacquers with improved gloss and color, but production was slow and labor cost high. Later it was found that the same principle of incorporating pigment in dry nitrocellulose and plasticizer could be extended to the banbury with reduction of manufacturing cost and this process is commercial in various plants.

For varnish manufacture gas and fuel oil have largely replaced coke fires. In many cases aluminum and Monel metal have been adapted for varnish kettles in place of copper. When the varnish manufacturer has undertaken the production of alkyd resins he has found that proper control required that he adopt the processing equipment of the resin manufacturer—stainless steel or aluminum kettles of at least 500-gal. capacity, heated with electricity or circulating oil, agitation, and other accessories.

To the layman the many types of paint, varnish and lacquer products would be confusing under any circumstances; but he is more confounded when almost every new formula is announced as a revolutionary discovery, and there is unrestrained competition in coining new words to disguise the nature of products. A brief discussion of finished products may serve, among other things, to partially dispel the mental fog that has been created.

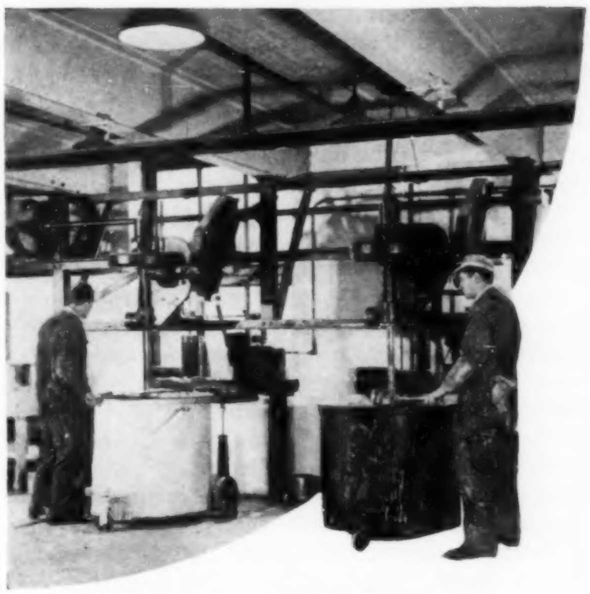
Interior walls provide the largest surface to be painted and coverings for them are therefore of primary concern both to the manufacturer and to the user. Not many years ago the first coat in wall painting was a regular flat wall paint or a varnish size, taking for granted that glue size is unworthy of mention. Flat wall paint did not seal the surface and permitted the vehicle or binder in subsequent coats to soak in, resulting in spotted color of tints and other less obvious faults. Varnish size sealed the surface, but did not contribute hiding and gave a surface with poor recoating properties. Progressive producers have met the problem with special pigmented wall primers that combine satisfactory sealing properties with hiding and good recoating characteristics. It is a simple matter to obtain any reasonable degree of sealing by the use of heat processed oil or resinous vehicles, possibly supplemented by surface treated whiting. However, the materials that favor sealing properties detract from brushing properties and the formulator must seek a happy compromise.

Finish coats for interior walls comprise flat, eggshell, semi-gloss and full-gloss paints. Today, the prevailing type of flat wall paint is made with lithopone or titanium pigments. Over a period of years there have been improvements in the better products in freedom from brush marks, hiding, washability and other properties.

Semi-gloss wall paints are being featured for their superior washability in comparison with flat paint. There is nothing very new about these semi-gloss wall paints except the sales drive. Washability is largely a function of gloss, and all hard drying semi-gloss paints are quite washable.

Gloss wall paints mean essentially gloss mill whites. Within the past year or two the better products of this kind have reflected improvement in brushing properties, spreading rate and hiding properties. Conventional gloss mill whites are made with heat bodied oils as the vehicle. For minimum yellowing properties the minimum amount of drier is incorporated and in some instances part of the oil is soya, both of which promote slow drying. Some new products have been made to dry much more rapidly by using alkyd resin vehicles, or tung oil and phenolic resin.

Water paints require mention in discussing wall paints,



**Scale mixers for portable tubs, most widely used equipment for blending and tinting colored products**

although they fall in a somewhat different category than oil and varnish paints. In the original type of calcimine the pigment was whiting and the liquid contained glue or starch as the binder. The opacity resulted from the low non-volatile vehicle content combined with the wide spread between the refractive indices of whiting and glue. Paints of this type are still employed to some extent when permanence of the finish and washability are of little concern. Of late there has been considerable activity in water paint of an improved type, casein paint. Hiding pigments, such as lithopone and titanium pigment, are employed. Paints of this type possess a number of excellent properties. They can be applied with safety on surface that are not thoroughly dried, since they permit moisture to pass through the relatively porous film without blistering or scaling. They are more resistant than oil paint to free alkali when present in excessive amount, and they hide well. In the white form they have about 10 per cent greater light reflectivity than oil paint and are non-yellowing. Being dead flat, they reflect light without glare. When the qualities that control serviceability are considered, their showing is less impressive. Due to low non-volatile content of the vehicle the film is porous and stains of a greasy nature penetrate and cannot be removed; even splashes of water may show spots. Because the casein binder is softened by water the paint is not washable in any practical sense, although it has been stated that it can be washed by a special technique that includes formaldehyde in the wash water and excludes rubbing. Casein paint has poorer adhesion to surfaces than oil paint and is more susceptible to mildewing.

Next in importance to wall paints are exterior house paints. Lead and oil continues to be the most popular exterior paint for white and tints, a popularity that is based on unexcelled weathering characteristics as well as tradition and the desire of the painter to "mix his own." While lead and oil has, for obvious reason, been standing almost still technically, mixed paints have been steadily improved in quality by skillful use of the great variety of pigments and other raw materials that are available. There can be no question of the superiority of mixed paints in hiding power, brightness of the white and color retention of tints. The proponents of lead, and some impartial observers, feel that there is also no question that lead offers the best long-pull protection, with less tendency to crack and scale and less possibility of a burn-off job being required. Many mixed paint manufacturers have reached the conclusion that whatever deficiencies mixed paint may have in this direction are explained by the fact that its substantial zinc oxide content detracts from its value as a primer. This is the explanation of the current promotion by mixed paint manufacturers of special multi-pigment house primers. These primers have little or no zinc oxide, the usual pigments being lead carbonate and titanium pigment. The vehicle is designed to give better sealing properties than straight raw linseed oil. These primers have been quite favorably received but experience with them in house paint has been brief.

Industrial finishes have appeared in such numbers and diversity that to more than mention a few of them would require a separate article. Among the more useful finishes are the wrinkle enamels that are seen on a variety of articles. A refinement of the crackle lacquer finish has led to products that closely simulate the appearance of old, crazed chinaware. Finishes for rubber and rubberized fabric constitute a large and growing market and the paint and lacquer manufacturer has developed many new materials to meet the varied, exacting demands. The great range of available raw materials gives the paint formulator a versatility that was impossible 10 or 15 years ago, and no matter what problem industry may present it is tackled with confidence in a solution.

# Chemical Trends in Petroleum Refining

By B. T. BROOKS
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MOST SIGNIFICANT of facts about the petroleum industry during the last 15 or 20 years is not the millions of barrels of oil it has raised to the surface, nor the increases in its capital investment and number of employees, but rather the great extent to which the industry now makes use of nearly every branch of science: chemistry, metallurgy, physics and geology, and the many engineering applications of these sciences.

Parallel with this change in the industry itself is the increasing attention which the chemistry and engineering of petroleum is now receiving from universities. When the plan for stimulating essentially theoretical research in the chemistry, physics and geology of petroleum, which was later administered by the American Petroleum Institute, was submitted to Dr. Van Manning by the writer, we believed that one of the long range benefits of that program would be the creation in the universities of centers of permanent interest in petroleum research. That that expectation has been realized is evident particularly by the work being done at Pennsylvania State College under Whitmore and Fenske; at Massachusetts Institute of Technology under Lewis; at the University of Michigan under G. G. Brown; in California under Uren and Lacey; at the University of Oklahoma under Bingham and Huntington; at Princeton under Taylor and Spence; at Northwestern under Hurd; at Johns Hopkins under Reid; and at the Bureau of Standards under Bridgeman, Rossini, Herschel and others. Some 41 research projects were carried out during the operation of this plan. In many instances these researches are still going on, although the original funds were long since expended.

A noticeable trend in the industry itself is the increasing number of researches which are being published from refinery laboratories. The liberal, progressive and stimulating policy of some refining companies, in this respect, is in marked contrast to at least a few of our chemical companies.

The great diversity in the problems requiring solution has led to the employment of a variety of specialized technologists. A staff of geologists may include experts in the use and interpretation of the seismograph, torsion balance or magnetometer. The production departments have required the study of corrosion and of special steels. Refinery problems have caused the art of distillation to be carried far beyond anything known heretofore in any industry. High temperature cracking and hydrogenation have called for a vast amount of new metallurgy of special alloys. A considerable part of this scientific and technical advance has come from specialists in the employ of equipment designers and fabricators.

About 1912 the rapidly increasing use of gasoline as motor fuel threatened to outstrip the supply available in the crudes. It probably would have been considered foul heresy to have mentioned such a possibility, but nevertheless those who were actuated by such belief developed the first successful cracking processes. Although the cracking of high boiling hydrocarbons to gasoline had been clearly indicated by earlier experimental work, this development was in many ways pioneering, and opened the way to much other profitable research. The value of the ensuing technical advances and the improved economic position of the industry would be difficult to overestimate.

With an increasing emphasis on the chemical or scientific points of view, all refinery processes and petroleum products came under more rational criticism. I can illustrate the common older attitude by the following example. When in 1912, we submitted a highly refined sample of cracked gasoline to the management of a large refining company, we were told that such a product could not be marketed because the odor was "not right." In truth, it did not have the odor that was associated with the light paraffinic, straight run gasolines of that day. But with the advent of cracked gasoline it was recognized at least as early as 1916 that gasolines differed in their value as to performance under heavy load and as to engine knock. The latter study later led to the first use of tetra-ethyl lead as an anti-knock compound by Midgley and Boyd. The automobile user became educated as to engine knock, until finally it was the highly paraffinic but sweet smelling gasoline that became unsalable as such.

### Octane Race Continues

The effort to produce motor fuel of higher octane rating still continues. Cracking temperatures have been raised until the average yield of uncondensed gas is about 10 per cent. Approximately one-third of this gas can be converted into gasoline by polymerization—a development which has had a great deal of publicity during the past year. Two types of polymerization processes are in successful commercial operation. (See *Chem. & Met.*, Nov., 1935, pp. 596 and 607.)

The octane value of crude polymer gasolines is generally about 78-82, and in a 25 per cent blend they impart non-detonating properties to the blend equivalent to having an original octane value of 100 to 125. This does not mean the passing of tetra-ethyl lead, as the quantities

of polymer gasoline which can be produced would be insufficient for such a result. But it does make possible the manufacture of special gasolines of high octane value without tetra-ethyl lead. There is need for all the polymer gasoline that can be produced, to improve the octane value of poor anti-knock gasolines and perhaps to offset the necessity for gasoline re-forming processes.

The search for organic compounds having high anti-knock value, which can be produced cheaply enough and in great enough quantity for special gasoline blends, such as aviation gasoline, still continues. Tests by the U. S. Army Aviation Corps of special fuels made up wholly or in large part of iso-octane itself, made by hydrogenating di-isobutene, show that the increased power, speed, and higher ceiling attainable with such a fuel, of 100 octane value, is great enough to be of considerable military advantage over planes using 85-87 octane fuel.

### Light-Weight Diesels to the Fore

The relative abundance of petroleum and the cheapness of gasoline have probably retarded the adoption of light, high-speed diesel engines for automotive purposes. Although this type of engine may be said to be as old as the gasoline engine, the development of light, high-speed diesels is comparatively recent. One factor retarding their wide use is the fact that at present small diesel engines cost 80 to 100 per cent more than gasoline engines of the same displacement. A four-cylinder, 90-hp., light, high-speed diesel engine suitable for automotive use now costs $1,550; and one of six cylinders and 120 hp. costs about $1,000 more. How much these costs can be reduced by quantity production is uncertain. However, the upward trend in gasoline prices which will accompany any shortage of domestic crude petroleum—or which may come with the definite anticipation of such a shortage—will expedite improvements making for more efficient fuel utilization.

Use of automotive diesels has also been retarded by the fact that many different fuel specifications set up by the engine builders cannot be commercially and economically supplied. This situation is in process of simplification by the A.S.T.M. According to Mendius, Ainslee and Schlesman (*Oil and Gas Jour.*, Nov. 14, 1935) there seems to be no need of supplying the high-speed diesel-fuel market with more than two grades of fuel. There are, at present, no distributing facilities for special diesel oils except in bulk. Some oils having cetene numbers below 40 are unsuitable for use as diesel fuels and many engine manufacturers require a minimum cetene number of 50. One of the present research activities is the study of reagents which, added to diesel oil in small proportions, will improve its ease of ignition, or cetene number.

In spite of the handicaps noted above the uses of diesel engines are increasing. Mendius, Ainslee and Schlesman noted that up to 1932 approximately 4,000,000 hp. of diesel equipment had been built in the United States and that "during the past three years the field of usefulness of the compression-ignition engine has changed. Between 1932 and 1935 the American public became conscious of the possibilities of the compression-ignition engine, with the result that 700,000 hp. additional of engines was created. The latter engines differ from their predecessors in one important respect: they are small, light-weight engines—the so-called high-speed diesel engines.

A process for converting gasoline to diesel oil, with reasonably low conversion costs, would appear to be rational if and when diesel automotive engines become more widely used. Diesel oil is normally included in the heavy oil stock used for cracking into gasoline. The yield of gasoline by cracking such heavy oil averages between 60 and 65 per cent. The car mileage per gallon of diesel oil is nearly double that for gasoline. As a conservation measure, therefore, it is of some importance that a car which will travel 15 miles on 1 gal. of gasoline will, at 26 miles per gallon of diesel oil in an automotive diesel engine travel 39 miles on the $1\frac{1}{2}$ gal. of diesel oil which is required to produce 1 gal. of gasoline by cracking.

In 1934 the production of motor fuels in the United States, according to the U. S. Bureau of Mines, was as shown in Table I.

**Table I—Production of Motor Fuels in the United States in 1934**

| | Millions of gallons | Per cent |
|---|---|---|
| Straight run gasoline | 8,672 | 48.4 |
| Cracked gasoline, refined | 7,662 | 42.7 |
| Natural gasoline | 1,521 | 8.5 |
| Benzol | 67 | 0.4 |
| Total | 17,922 | |

If automotive diesel engines come to be widely used, due either to conservation or to driving economy, a very large proportion of the cracked gasoline now being manufactured need not be produced. If the trend continues to be to more and more gasoline, rather than to automotive diesels, the development may be forced toward the manufacture of gasoline by the hydrogenation of heavy oil residues or coal, or both. Russell, Voorhees and Gohr (*J. Inst. Petr. Techn.*, Vol. 21, p. 352, 1935) have suggested that hydrogenation be combined with cracking processes. By cracking alone heavy oils yield about 60 per cent gasoline, and by complete hydrogenation about 108 per cent gasoline and no fuel oil residuums are obtained. Combination of the two processes, hydrogenating a portion of the recycle oil, gives optional flexibility between these yields.

In the larger refineries the tendency of recent years to build larger and larger units for distilling and cracking continues. Building of larger cracking units combining stripping and cracking has been favored by the possibility of utilizing the surplus heat of cracking units for stripping the original crude. Combination atmospheric and vacuum units for distilling crudes have also been designed in larger and larger units. The largest to date is such a combination atmospheric and vacuum distillation unit having a daily throughput capacity of 65,000 bbl., which is being designed by American engineers for the Anglo-Iranian Oil Co.

The advantages of larger units, particularly greater throughput per dollar of plant investment, less labor and in some cases better heat economy, are at least partly offset by the fact that a shutdown for minor repairs is more costly and the lack of flexibility in plant operations

when operating may be a disadvantage. Combination atmospheric and vacuum distillation units of much smaller size than 65,000 bbl. have given considerable trouble in American refineries in which the crude supply is derived from several fields in varying proportions.

It was early recognized that there was an element of mystery in lubrication. In general, highly refined lubricating oils are very poor lubricants. They do not stand up well under heavy loads, often causing metal seizure in bearings and gears. Under moderately heavy loads and in service they oxidize rather readily, which results in corrosion of metals. A variety of substances has been tried to improve the "oiliness" of lubricating oils, or the property of lubrication under heavy loads. Lead soaps, sulphurized oils and chlorinated benzenoid compounds have been used; one of the pioneer investigators has recently adopted chlorinated stearic acid esters for this purpose.

The refining of lubricating oils by extraction with solvents such as phenol, nitrobenzol, Chlorex (dichloroethyl ether), furfural, cresylic acid with liquid propane, etc., has been thoroughly discussed in *Chem. & Met.* (See April, 1935, pp. 246-50.) Although such processes make it possible to separate oils of the paraffinic type, having good viscosity index characteristics, they are like other highly refined lubricants in that they have a poor load-carrying capacity. Little has been said of this defect, but the advantage of such solvent extraction processes in other respect has greatly increased the fundamental study of lubricants and accentuated the importance of addition products for the purpose of improved lubrication.

Our present consumption of lubricating oils represents less than 3 per cent of the crude oil produced in the United States, and much more could be manufactured from our present supply of crude oil, if there were a greater demand for lubricants. The trend in recent years (see Table II) shows clearly that the consumption of lubricating oil has not increased proportionately with greater gasoline consumption. This has undoubtedly been due to better automobile engine design and accessories.

The relative abundance and cheapness of petroleum products has apparently retarded the manufacture of lubricating oils by polymerization. As shown by Sullivan and his associates, lubricating oils of excellent viscosity characteristics can be made by the polymerization of long chain olefins made by cracking paraffin wax. Lubricating oils have also been made by the hydrogenation of heavy oil residuums, and Fischer, in Germany, has produced lubricating oils from the low boiling hydrocarbons formed by hydrogenating carbon monoxide, by polymerization and by chlorinating and treating with aluminum or aluminum chloride.

The use of liquid propane in the manufacture of lubricating oils has been in commercial operation for about two years in the plant of the Union Oil Co. of California. Acetone-benzol was the first of a series of solvent processes to be used in the dewaxing of oils. While some chlorinated solvents have been used, one of the latest plant installations uses a mixture of methylethyl ketone and benzol. This ketone is now produced on a large scale by the catalytic dehydrogenation or oxidation of secondary butyl alcohol. The principal advantage of these solvent dewaxing processes is that dewaxing can be carried out with a much smaller difference between the dewaxing temperature and the desired pour point than is possible in the older processes using naphtha dilution.

In a report made last year, to a sub-committee of Congress. The United States Geological Survey stated[1] "It should be urged that making provision in advance against the day, certainly not long distant, when waning domestic petroleum reserves will fall shorter and still shorter of meeting American domestic needs is not only natural and logical—it is fundamentally sound and necessary."

The evidence for a shortage in our domestic supply of petroleum occurring in about five to eight years has been discussed by Dr. L. C. Snider and the writer in another paper. (See *Chem. & Met.*, September, 1935, p. 520.) There is no reason for hysteria at such a prospect and no good reason why the subject should not be discussed in unbiased scientific and technical forums.

Throughout the history of the petroleum industry the relative proportions of the major products has continually changed, is still changing, and will continue to do so. The record is shown by data from the United States Bureau of Mines, given in Table II.

**Table II—Principal Products from Crude Oil**

| Year | Gasoline and Naphtha, Per Cent | Kerosene, Per Cent | Gas Oil and Fuel Oil, Per Cent | Lubricants, Per Cent |
|---|---|---|---|---|
| 1914 | 18.2 | 24.1 | 46.5 | 6.6 |
| 1918 | 25.3 | 13.3 | 53.5 | 6.2 |
| 1920 | 26.1 | 12.7 | 48.6 | 5.7 |
| 1922 | 28.8 | 11.0 | 50.9 | 4.7 |
| 1924 | 31.2 | 9.3 | 49.8 | 4.3 |
| 1926 | 34.9 | 7.9 | 46.9 | 4.1 |
| 1928 | 37.4 | 6.6 | 46.7 | 3.8 |
| 1930 | 42.0 | 5.3 | 40.2 | 3.7 |
| 1932 | 44.7 | 5.3 | 35.9 | 2.7 |
| 1934 | 47.4 | 6.0 | 37.5 | 2.8 |

Changes necessitated by increasing shortage will, of course, be gradual. The trends shown in Table II will probably continue, since the products of lower value will be converted, as far as possible, into products of higher value. Thus the greatest changes may be expected in the fuel oil and gas oil class.

In 1934 the domestic consumption of fuel oil was 325 million bbl., of which 178 million bbl. was residual oil from cracking. The remaining uncracked fuel oil is mostly heavy oil of relatively poor value as cracking stock. This is relatively little margin for the further increase of our motor fuel supply by cracking.

Distillate gas oils have recently been replaced to an important extent by fuel oils, for gas enriching purposes. An increase in the use of diesel oil, particularly for automotive purposes, will inevitably result in upward price readjustments for gas oil; the tendency being the replacement of distillate gas oil by fuel oil (A. Johnson, *Chem. & Met.*, Vol. 39, p. 663, 1932).

Fuel oils have served for years as a dumping ground for surplus oils which could not be sold more profitably. In this field the price has largely been governed by the price of coal.

The analytical statistics, compiled by the Bureau of Mines, of the uses of gas oil and fuel oil by industries

[1]Petroleum Investigations; Hearings before Subcommittee in Interstate & Foreign Commerce, H. R. 441, 73d Congress, Washington, 1934, p. 892.

**Table III—Major Uses of Gas and Fuel Oil in the United States**
(in 1,000 bbls. of 42 gallons each)

| Industry | 1926 | 1928 | 1931 | 1934 |
|---|---|---|---|---|
| Railroads | 72,217 | 70,680 | 58,150 | 52,581 |
| Steamships | 79,287 | 89,942 | 83,558 | 69,262 |
| Gas and elec. plants | 33,651 | 30,901 | 24,490 | 23,143 |
| Iron and steel | 16,102 | 19,429 | 12,855 | ...... |
| Smelters and mines | 8,941 | 6,897 | 3,626 | 4,814 |
| Other manufacturing | 23,017 | 10,023 | 9,998 | ...... |
| Commercial heating | 13,874 | 16,427 | 15,731 | |
| Domestic heating | 3,905 | 5,971 | 10,466 | 60,822 |
| Furnace oils, domestic | 6,300 | 8,300 | 14,213 | |
| Oil companies | 48,701 | 50,044 | 51,196 | 47,404 |
| Miscellaneous | 7,514 | 12,757 | 10,266 | 12,253 |
| U. S. Navy | 6,541 | 8,368 | 9,203 | 7,914 |
| Exports & other shipments | ..... | ...... | 29,231 | 28,605 |

do not distinguish between the two types of oil, or between distillate and residual oils. The figures of Table III are of interest mainly as showing the industries using large amounts of these oils, rather than as indicating definite important trends. The relatively small proportion of the total required by the U. S. Navy is of note.

In the production department of the oil industry there is a well marked trend toward higher average costs of production. This is due to the greater proportion of deeper wells and to other causes. The average cost of drilling a well in Oklahoma increased from $3,169 in 1912 to $45,574 in 1928. According to the American Petroleum Institute the cost of a typical well in the Earlsboro Pool, Oklahoma, depth 4,350 ft., was $60,700 (in 1928). In the same year a typical well drilled to 6,000-6,500 ft. in the Los Angeles Basin cost $139,523, of which $67,148 was for material alone. A typical well in the Kettleman Hills field, down to 7,200 ft., cost a total of $197,737 ("Petroleum Facts and Figures." Am. Petr. Inst., Ed. 2, New York, 1929). In the six 1934 discoveries in the Gulf Coast Area the depth was 5,000 ft. in one, 6,000 ft. in one and below 7,000 ft. in four. A well recently drilled by the Gulf Refining Co. to a depth of nearly 13,000 ft. is reported to have cost about $500,000. The greater cost of deep drilling has a tendency to limit wild-cat drilling to strongly financed companies, who also have competent geological staffs.

Periods of surplus production have always brought into existence many small skimming plants, often miscalled "refineries." Only a few of these ever survive. No less than 75 small plants are credited to the production, partly illegal, of the East Texas Field. Really effective control of production might do away with most of the "hot" oil and "distress" crude, but a shortage of domestic crude would certainly do so. Since about 92 per cent of our proven reserve supply of crude is owned by 18 companies it is evident that the elimination of surplus production, or a domestic shortage, will put those refineries who do not own their crude requirement under a severe handicap and will doubtless eliminate most of them.

Although the question of a shortage of domestic petroleum, possibly developing in a few years, is not a chemical question, the refining and utilization of petroleum is becoming more and more a matter of chemical engineering. In view of its growing utilization as a chemical raw material, the probability of higher prices for this raw material, due to domestic shortage and increasing dependence upon imports, should be of general interest to chemical industry. Also the manufacture of petroleum substitutes, which has made such progress *outside* of the United States, should be of interest. All that space permits, in this discussion, is to indicate the trend in other countries to develop petroleum substitutes.

In view of the fact that gasoline has been as high as 14c. per gallon in bulk, f.o.b. Mid-Continent refineries in the post-war period, in 1922, and since the plant cost of gasoline from coal by hydrogenation is reported to be about 16c. per gallon, the manufacture of gasoline from coal in the United States may not be so remote as some appear to believe.

In England the much heralded Billingham coal hydrogenation plant, reported to have cost $30,000,000, has been in operation a few months. (*Chem. & Met.*, Dec., 1935, pp. 658-60.) Another plant, not so widely advertised, has been erected during the past nine months by Coal and Iron Industries, Ltd., at Seaham Harbor. Alec Day (*World Petroleum*, Oct., 1935, p. 586) states, "The British Government is not only supporting production of synthetic oil products from coal by a large consumption in its military departments and by substantial rebates in taxes imposed on both heavy and light fuel oils, but is also delving into the actual manufacture of these products . . . and improving on present methods of plant construction and operation. One of the foremost programs of the Department of Scientific and Industrial Research . . . deals with the conversion of coal tar to synthetic oil products" [by hydrogenation].

In Germany the hydrogenation of coal has been energetically developed and it is reported that by 1936 the production of motor fuel by hydrogenation will amount to 200 million gal.

## What Source Future Fuel?

Commenting on the motor fuel problem in relation to inter-fuel competition, R. S. McBride, author of the article on pages 14 to 16 of this issue, declares that it is not of importance to the motorist, nor to the national economy in its broadest sense, whether the motor fuel supply comes from one source or another. Unless arbitrary factors are imposed from without, the inter-process and the inter-commodity competition of today will work out constantly new relationships. At each stage the objective of the gasoline maker will be to put a high-grade motor fuel into the auto gas tank at the lowest feasible cost for material, labor, capital charge, and distribution expense.

Unfortunately the greatest attention on the part of the public is directed toward the second or third of these items, which are the smallest in actual importance to the motorist when he buys his gasoline. There is a great commotion over new processing methods; and there is quite a hubbub from time to time about competing materials. However, the chemical engineer processes all the raw materials so efficiently that the labor and capital charge involved are probably less than a quarter of the average tax paid to states on each retail sale. Hence in today's retail price, tax is biggest, distribution expense is second, raw material cost is third, and the processing expense is a poor fourth in the price burden on the motorist. Improvements in processing will come, but they cannot revolutionize the pump price of the gasoline.

# Trends in Inter-Fuel Competition

**Demand for better processing efficiency because of inter-energy competition, creates new chemical engineering fuel problems.**

**By R. S. McBRIDE**
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FLUID FUELS and electrical energy are often interchangeable sources of energy supply for process industries. As there is a chemical engineering advance in the preparation or delivery of one of these there is a corresponding advantage for it, and equivalent disadvantage for other materials. Inter-process competition is, therefore, almost as important a factor as the inter-energy conflict. And, too, this whole situation applies to the products of fuel processing wherever they may be used, even gasoline in the automobile, for example.

Sharp debate has been in progress recently as to the threatened shortage of crude petroleum. Even more bitter controversy has been raging over the governmental policies involved in the development of hydroelectric power. Tariffs on imported petroleum, new burdens imposed on coal, and the rapidly changing labor picture, which affects the processing of both, have added further complication to the situation. Tremendously increased supplies of natural gas and the products of its processing, such as natural gasoline, propane, and butane, are almost equally significant factors. Fundamental reappraisal by chemical engineers is much needed.

For many years the share of anthracite and bituminous coal in the energy supply of America has been shrinking. In 1889 anthracite supplied nearly 30 per cent and bituminous approximately 60 per cent. Today anthracite supplies about 8 and bituminous coal has declined from a peak of 70 per cent in the immediate prewar period to about 45 per cent. Petroleum, which cared for less than 5 per cent of the energy requirements 30 years ago, now takes care of more than a quarter of the total energy demand.

In 1934 official figures credited domestic oil with 26.9 and imported oil with an additional 1.1 per cent, a total of 28 per cent of America's energy needs. Natural gas and water power have had more or less parallel growth from 2 to 3 per cent, each early in the century to their present importance of approximately 9 per cent each. As a result of these readjustments, anthracite is rather a poor fourth in the competition, being preceded in importance not only by bituminous, but also by both natural gas and water power.

In some respects this changing relationship is the result of the relatively greater importance today of the automobile. Secondarily, it is the result of substitution of other fuels for coal. And, thirdly, it comes about because of the substantial increase in efficiency with which bituminous coal is used both for heating and for the generation of electric power in steam-electric plants.

The decline in consumption of bituminous coal from approximately 500 million tons per year to the present typical requirement of 300 million tons, has been caused about equally by two changes. Roughly 100 million tons of coal per year are not now needed, simply because mechanical engineers have given us superior boilers and power-plant equipment. Efficiency in steam raising and in conversion of steam to electricity saves this 100 million tons a year.

The second reason for the decline has been substitution of natural gas and petroleum, perhaps again about equally important. Hydroelectric development has not usually occasioned substitution for coal. It has more often been merely a new source for energy, satisfying the growth in demand rather than supplanting former coal requirements.

At present it seems likely that despite constantly growing demand for energy in the United States the demand for bituminous and anthracite will not increase significantly within the near future. Improvement in efficiency of use and substitution continue at such rates as about to meet the growing energy demand of the country as a whole.

Nevertheless, it may be that a new factor will enter into this situation. The cost of energy is declining. Meanwhile the cost of materials and of labor are advancing, the former under the influence of inflation factors and the latter because of important general social trends. Hence, a wastefulness with respect to energy may soon be necessary wherever this "waste" may save either labor or materials. Only time can tell how important this trend will be.

## Petroleum's Changing Picture

From the standpoint of the chemical engineer the most important of the petroleum trends are those which center around refinery and related practices. No longer is the preparation of motor fuel a matter of mere fractionation and cracking of petroleum. Economic factors have compelled quite a different approach than was prevalent even 5 or 10 years ago, when the most serious of the petroleum refiners' problems seemed to be the getting of a larger yield of motor fuel from out of the crude oil.

(Editor's Note: For further information on motor fuel trends, see article by B. T. Brooks, pages 10-13 of this issue.)

One important market for petroleum products is becoming highly competitive with the motor fuel market. This is the house heating demand for light fuel oil. Some of the oil so marketed is really an excellent cracking stock. The refiner, therefore, is able either to convert it into gasoline efficiently or to market it "as is" to the householder or building operator who has an oil-fired furnace.

Fortunately for the petroleum industry the seasonal demand curves of the two markets are almost exactly supplementary to each other. In times when gasoline requirement is least, the heating load takes up what would otherwise be a burdensome surplus of light fuel oil. For economic reasons, therefore, the refiner is glad to have the house-heating market growing steadily, even though this growth may slow down the trend to higher yields of motor fuel per barrel of crude run to stills. Incidentally, the thermal efficiency of fuel marketed per B.t.u. in the crude is greater under these circumstances. Thus, those ardent conservationists who are shocked at the thought of selling fuel oil in a crude form, instead of refining it to a motor fuel, have something to comfort them in their mental anguish.

Other inter-fuel competitive factors are rapidly accelerating the trend to oil-fired furnaces. The cost of anthracite is relatively higher today than ever before. The cost of bituminous coal is likely to be advanced, if, as, and when the bituminous industry is placed on a profit-making basis with decent wages for its mine workers. All these influences make petroleum heating cheaper as compared with solid-fuel heating. Incidentally, they also add to the difficulties of reestablishing the much-needed market for bituminous.

But the important thing in connection with the present discussion is the fact that, as solid fuel becomes more costly per million B.t.u., fluid fuel is more feasible of use in many competitive applications. Thus, the trend toward higher gasoline yields from crude is markedly slowed.

### City Gas Competition

The competition among raw materials to supply city-gas utilities continues keen. Natural gas has displaced substantial quantities of manufactured gas, and will continue to dominate areas to which it can be pumped economically. But even in those areas there is a real problem for engineering analysis in the determination of which raw material shall be used for supplementing the base load at seasons of peak demand. Since carburetted water gas can be made with equipment requiring a minimum of capital investment per unit of generating capacity, this gas is most widely favored among manufactured gases for peak-load supply. Modern engineering developments have so modified standard old-style water-gas methods that the engineer today may make at will high gravity or low gravity, high B.t.u. or low B.t.u. Hence peak load gases can conform to base load supplies in both distribution and appliance-burner characteristics.

Another consideration importantly entering into the present competition has been brought about by skillful development of water-gas processes successfully to handle very heavy high-carbon oils. Several equipment builders have made advantageous developments of this sort, each of which contributes substantially to economy in gas making because it permits the use of cheaper oil for enrichment.

In a number of cases propane or butane, or their mixtures, have been successfully used for amplifying gas supplies during seasonal peaks. Oil gas is occasionally made also. And in a few instances utility men even depend upon petroleum refinery gas for peak-load supply. However, this gas is proving more important in city supply for companies which are able to buy and mix it regularly, not merely at high-load seasons.

There has been considerable talk about the importance of surplus refinery gas which has been based on false premises, the result of inadequate understanding of economic conditions. For example, it is not reasonable to assume that a refinery located near a city will necessarily find it advantageous to supply the local utility with some rich refinery gas. The utility in order to make a satisfactory contract must have assurance of continuous supply. It cannot set up its plant arrangements on the assumption that it will take any quantities offered at the option of the refiner. And an interruption of refinery-gas supply can be tolerated least of all. On the other hand, the refiner hesitates to make a contract even at a favorable price when he must commit himself to certain quantities of gas supply regardless of whether the refinery would otherwise run to that capacity or not. In other words, the refiner hesitates to allow the utility customer to become such an important tail of his refinery dog that he may find his entire operating program governed by the terms of his gas sales contract.

Still less likely of extensive development are chemical products based on refinery gas as raw material. The ethylene and propylene output of one or two large refineries if completely processed into the much discussed chemicals which can be made from it could flood the market and break prevailing prices to unprofitable levels. This explains why those theorists who forecast chemical utilization of *all* refinery byproducts are not convincing.

### Natural Gas Byproducts

The large supplies of propane, butane, and pentane have not stimulated their really deserved attention. Few people have sensed the fact that there is about half as much energy available for America in these condensable hydrocarbons as is utilized in all the natural gas itself, even including that gas used in the field, for carbon-black manufacture, and in crude heating operation.

These intermediate hydrocarbons are too heavy to pump with the gas, too light to include with the motor fuel. Thus they must, for effective use, be separated and transported by themselves. When so handled they are an ideal form of industrial fuel. They have the advantage of storability as liquid in tanks maintained at moderate pressures and the advantage that they may be handled like gas when the time comes for utilization. There is a marked tendency, therefore, to increase their application as a substitute for other fuels in plants where gaseous fuel for process heating is advantageous.

Wider utilization is to be expected, also, in public utility systems, and for space heating, cooking, and water

heating in isolated establishments not reached by gas mains. In these latter applications the liquefiable gases are decidedly superior to those heavier hydrocarbons commonly employed in making cold-process gas. They make a much more uniform heating mixture and one of greater ease of control. They may be handled either bottled or in pressure tank wagons. All stages from the 100-cu. ft. cylinder up to the 10,000-gal. tank are feasible.

For all of these purposes it is far better to utilize carefully refined material rather than the mixtures of the several hydrocarbons in the proportions which happen to occur together. For cylinder usage propane is most advantageous, because it is self-vaporizing even in the coldest weather commonly experienced. Butane is more commonly used in larger scale household or small industrial jobs. Quite recently new types of equipment have been developed which make pentane an advantageous air-gas raw material.

### New Fuel Sources and Power Alcohol

The considerable commotion made by proponents of power alcohol has given many the impression that this development is just around the corner, like prosperity. But the corner seems equally hard to find and turn. The fact is that alcohol is probably a poor second, possibly third, in economic succession still ahead as the need for substitutes for petroleum develops. Processing of heavy oil by hydrogenation to amplify gasoline supplies from crude oil has been well established as an economic possibility. Further development of that possibility seems likely to occur, perhaps as a natural companion of the polymerization processes. Actually in the making of poly gas much hydrogen will be cheaply supplied; this will, of course, accelerate the hydrogenation trend.

But both those developments are merely adaptations of petroleum refining to new business conditions. One can rightly say that a new raw material has been used only when it is something other than petroleum or its derivatives. Hence the first really new step will come when coal, oil shale, or agricultural raw material enters. Coal is likely to be the first of these used. Hydrogenation of coal is but a shorp step beyond hydrogenation of heavy fuel oil. As a matter of fact, when hydrogenation processes become thoroughly economic in America it may well be that the raw material treated will be a suspension of powdered bituminous coal in heavy oil. Such a development seems technically probable, and far more than possible economically.

One does not need to assume carbonization or related treatment of coal when one forecasts it as a motor-fuel raw material. Yet there are reasonably well established carbonization possibilities which can make available 20 to 30 gallons of liquid product per ton of coal processed.

Such processes for treating coal are far more likely to be developed in America than processes using oil shale. They make the quantities of liquid fuel and marketable or usable gaseous products in about the same quantity per ton of coal as could be made per ton of rich oil shale. And, furthermore, the 60 per cent of solid residue is also usable fuel, not a discardable material which requires expenditure for disposal as in the case of spent shale.

Power alcohol from agricultural raw material, such as corn or waste wood, might afford a splendid outlet for the surplus production of American agriculture and forestry. Unfortunately, however, the economics of the situation do not warrant any forecast that this trend will rapidly become important in either motor-fuel or other fluid-fuel supply. It is quite likely that quasi-subsidized enterprises making alcohol may succeed in manufacturing some millions of gallons per year in the not too distant future. But a realistic approach to cost estimates indicates that such motor fuel would cost at the point of production from 2 to 3 times the present refinery cost of gasoline. And despite all proponents' claims to the contrary, the alcohol is a little less advantageous to the motorist per gallon than gasoline, all things considered. The only justification for subsidy, if one dare call it justification, is the fact that this form of farm relief produces something useful, does not merely plow under little pigs.

**Per Cent of Total B.t.u. Equivalent Contributed by the Several Mineral Fuels and Water Power in the United States**

*(Data from U. S. Bureau of Mines)*

| Year | Anthracite | Bituminous | Oil (Total crude including that refined) | Natural Gas (Total production) | Water Power |
|---|---|---|---|---|---|
| 1889 | 28 | 60 | 5 | 5 | 2 |
| 1899 | 22.1 | 68.2 | 4.6 | 3.3 | 1.8 |
| 1909 | 15.5 | 70.2 | 7.7 | 3.7 | 2.9 |
| 1919 | 12.7 | 64.6 | 13.7 | 4.3 | 4.7 |
| 1924 | 10.8 | 57.0 | 21.4 | 5.5 | 5.3 |
| 1929 | 7.6 | 52.8 | 24.6 | 7.7 | 7.3 |
| 1930 | 7.9 | 51.4 | 24.1 | 8.8 | 7.8 |
| 1931 | 7.9 | 48.6 | 26.4 | 8.6 | 8.5 |
| 1932 | 7.5 | 44.9 | 27.8 | 9.1 | 10.7 |
| 1933 | 7.1 | 45.1 | 29.4 | 8.3 | 10.1 |
| 1934 | 7.7 | 46.3 | 28.0 | 8.7 | 9.3 |

### Electric Competition Intensifies

The imponderable fuel, electricity, has become a real competitor of some fluid fuels. This is true primarily in utility supplies of gas; but, incidentally, it is now becoming an even more serious competitor for bituminous coal. Undoubtedly two-thirds or three-fourths of the electricity produced at hydroelectric stations supplants coal as a primary energy source. There would be, therefore, nearly a 20 per cent increase in demand for bituminous if hydro sources were suddenly cut off.

The competition between electricity and gas as municipal utility supplies is by no means as serious as most gas company executives make out. Electric utilization is close to the theoretical peak of efficiency. Gas utilization is at an absurdly low figure for all but a few processes. What the gas man needs is not to be freed from competition with electricity: he needs far more to be freed from those restrictive standpatters in management who have been imposed on the engineers of the industry from without. Given a free hand in research and development work the operating and sales engineers of the gas business could easily out-distance their electric competitors for the vast majority of applications for which both types of utility service are at all applicable.

Another factor in the utility problem affecting fuel supply is the question of public ownership or public control. Regulation of gas utilities has been moderately successful in certain states. But the influence of regulation has not been enough to offset in the public mind those evils, real and alleged, which have come from an offensive mixture of politics with either management or regulatory bodies or both.

# Metallurgical Trends Of Chemical Engineering Interest

By CLYDE E. WILLIAMS
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MATERIALS OF CONSTRUCTION are becoming increasingly more important to the economics of chemical industries due to the more severe requirements of some of the new processes and to the changes of practices made to gain greater efficiency. As a result of increased fundamental knowledge of the science of metals, and the increased efforts of industry to develop better materials, the achievement in the quality of structural materials in recent years has been rapid.

Through painstaking research and practical application, the steel industry has learned much about the chemistry of steel working. It is now possible to make plain carbon steel of high and uniform quality. It is no longer necessary to add alloys to offset careless practice. And in the case of fine quality carbon steels maximum advantage can be taken of the effects of alloying agents.

Nickel, chromium, molybdenum and other materials have been used by the metallurgist to improve the mechanical and corrosion-resistant properties of steel. Several low-alloy, high-strength steels have been developed in order to secure materials offering these improvements at a modest additional cost. These steels usually contain from 2 to 3 per cent of the alloying agent. They possess 80 to 100 per cent higher yield strength than the low-carbon plain steels, and have several times the resistance to atmospheric and probably other corroding media. Among those being investigated are: the 1 per cent copper, 0.5 per cent nickel, 0.1 per cent phosphorous; the 1-1.5 per cent copper, 0.5-0.7 per cent nickel, 0.15 per cent molybdenum; and the 2 per cent nickel, 1 per cent copper alloy steel.

For severe corrosive conditions the stainless steels have been developed. Advantages offered by the steels containing 12 to 15 per cent chromium with carbon under 0.12 per cent (or in some cases where greater hardness is essential, under 0.18-0.20 per cent) are high tensile strength and toughness combined with good ductility. While they are not as resistant as the higher alloy steels, they have been used successfully for handling the more concentrated nitric acid solutions and other chemicals, and in certain petroleum refinery equipment. The alloy with 16 to 18 per cent chromium and carbon under 0.10 or 0.12 per cent is one of the most useful of the stainless group. It has excellent corrosion resistance, is reasonable in cost, and has wide general utility.

The effect of nickel in stainless steels is to increase their resistance to corrosion by both oxidizing and reducing solutions. It also improves the mechanical properties. The 18 per cent chromium, 8 per cent nickel steels were first introduced in America as a substitute for plain chromium steels for use in petroleum refineries. Their possibilities were at once recognized and the use of this steel spread rapidly to other process industries.

In an attempt to meet demands from industry for metallic materials possessing a wide variety of mechanical and chemical properties, metallurgists have developed many modifications of the 18-8 alloy. One of the earliest and most useful of these contains from 2 to 4 per cent molybdenum. It is used in sulphite liquors, acetic acid and zinc chloride. One of the largest users of this material is the pulp and paper industry.

The replacement of about one-half the nickel in the 18-8 type of alloy by manganese is said to improve its resistance to a large number of corroding media. By reason of superior ductility and softness, this steel is excellent for deep drawing and other drastic cold working operations.

The introduction of nitrogen into chromium-nickel steels improves machinability and provides non-magnetic castings of relatively high strength. Little difficulty is met in welding the alloys; and these mechanical improvements are not obtained at the sacrifice of corrosion resistance.

A recent development of much promise is the production of stainless-clad and nickel-clad steels formed by welding sheets or rolling slabs of the metals together. This development ultimately should result in a cheaper product of equivalent corrosion resistance and in some cases, better structural properties.

Castings are useful materials owing to the ease of production in various intricate shapes, the ready machinability, and the low cost. Vast changes in production have been made, as in the case of rolled steel products. These have been due to the improvements in steel making practices and greater knowledge of the effects of alloying agents. The former difficulty of producing an occasional batch of castings of low ductility may now be avoided by paying attention to the chemistry of steel making, suitable melting, refining and deoxidation practices. By control of the silicon and carbon contents in plain cast iron, a product of high tensile strength (up to 50,000 lb. per sq.in.) may be produced; and by controlling the structure of the metal and avoiding large particle size of the cementite and graphite mechanical properties may

be further improved. Moreover, additions of other metals, such as nickel, chromium, copper, aluminum, either alone or in pairs, plus superior qualities obtained by better metallurgy, add 10,000 to 20,000 lb. per sq.in. to the tensile strength and improve other properties of cast iron to a similar extent.

In the case of stainless steels it is particularly advantageous to be able to use castings because of the working and fabricating difficulties. Practically every type of stainless composition which is rolled or forged, and many others which are not wrought because of poor forgability, are being produced in cast form. A recent development has been the addition of about 0.25 per cent of nitrogen to high-chromium steel castings; this reduces the grain size of the castings and makes them tougher.

One of the best known casting alloys in the chemical industry is the 14 per cent silicon iron. For years it has given satisfactory service in pumps, and other equipment handling sulphuric acid and certain other chemicals. A few years ago a modification of this alloy containing 4 per cent molybdenum was brought out for handling hydrochloric acid.

## High-Temperature Service

Metals used at elevated temperatures are subject to corrosion by the products of combustion of the substance being treated and, in addition, exhibit the phenomenon of plastic deformation (creep) which tends to increase as the temperature or the stress is increased. Thus stability at high temperatures is one of most severe requirements to which metals may be put. Under a tensile stress of 6,000 lb. per sq.in., and at a temperature of 900 deg. F., after the initial deformation, plain carbon (0.08 per cent carbon) steel will be deformed at the rate of 1 per cent in 10,000 hours, whereas an 18 per cent chrorium, 8 per cent nickel steel of the same carbon content may be held at 1,200 deg. F. and at the same load to give the same rate of deformation.

The use of 12-15 per cent chromium steels marked the first real advance in securing satisfactory high-temperature properties under extreme conditions. They hold their strength well at elevated temperatures and will resist scaling at temperatures below 1,500-1,600 deg. F. The 20 per cent chromium steels will resist long exposure at high temperatures under oxidizing conditions, to sulphur and to oxides of nitrogen. These alloys are useful for all types of low-pressure equipment which are subjected to oxidation up to about 2,000 deg. F., such as furnace parts, trays, muffles and retorts. Alloys with about 26 to 28 per cent chromium, when exposed to oxidizing atmospheres up to 2,100 deg. F., or slightly higher, maintain their surface indefinitely. They accumulate a very thin, tough, adherent scale which appears to act as a protective coating against further surface deterioration.

The addition of titanium or columbium to plain chromium steels modify the action of the carbon and thereby effects some interesting improvements. In steels containing less than about 12 per cent chromium an appropriate addition of either of these agents augments the resistance to oxidation at high temperatures and minimizes air hardening tendencies.

As the result of efforts to secure a cheaper product that would withstand high-temperature conditions the 4-6 per cent chromium steels were developed. When used between 800 and 1,200 deg. F., creep resistance and short time ultimate strength of these steels are greater than for carbon steel. Although nearly all of this type of low-chromium steel has been used in the form of tubes, some plate stock has been fabricated into equipment for conveying high-temperature gases around recuperators in petroleum refineries. It has been stated that additions of titanium or molybdenum to the 4 to 6 per cent chromium steels improve the corrosion and scaling resistance, thus making them more adaptable to such equipment as air preheaters, super-heater tubes, and heat exchangers.

There are several other products that are cheaper than these highly alloyed steels, and yet have considerably better properties than plain carbon steels for many applications. One such steel contains 0.5 per cent molybdenum, however, a better combination of strength and corrosion resistance may be obtained with a 0.10 —0.15 per cent carbon steel containing in addition to 0.5 per cent molybdenum, 0.75 per cent silicon, and 1.25 per cent chromium. It is claimed that this steel has as good or better creep resistance than the 4-6 per cent chromium steel, but less corrosion and oxidation resistance.

For temperatures between 1,600 and 1,800 deg. F., alloys containing very high chromium and nickel are used. A 25 per cent chromium, 12 per cent nickel composition is used, although one of 29 per cent chromium and 9 per cent nickel is preferable, where corrosion by sulphur dioxide must be combatted. For still higher temperatures, where corrosion from sulphur dioxide is not serious, 35 per cent nickel, 16 per cent chromium iron alloys are used.

Another special alloy composition that is extensively used for high-temperature service contains 13-15 per cent nickel, 5-7 per cent copper, 1.25-4 per cent chromium, 1-1.5 per cent manganese, 1-2 per cent silicon and 2.75-3.1 per cent carbon. This material may be readily cast and finds its greatest usefulness in installations where corrosive conditions drastically reduce the useful life of plain or low-alloy cast irons. The alloy is widely used in pump castings or pump linings, in valves, or in equipment handlings oil crudes, caustic, etc. Its oxidation resistance is 10 to 12 times that of plain gray iron. Since it is not susceptible to growth, this alloy serves well in fans, blowers, and other installations subjected to elevated temperatures and corrosive vapors.

## Non-Ferrous Alloys

In the non-ferrous field several notable advances have been made in the development of materials for use at elevated temperatures under corrosive conditions. The most interesting alloys that have been developed are the 70 per cent nickel, 30 per cent copper alloys to which aluminum or silicon has been added. The heat-treated alloy containing about 3.5 per cent aluminum possesses a tensile strength at room temperature of over 160,000 lb. per sq.in. while retaining all of the corrosion resistance of the plain nickel-copper alloy. High-strength properties are retained at elevated temperatures, for example, at 1,000 deg. F. the tensile strengths range from 75,000 to 125,000 lb. per sq.in. and the yields strengths from 33,000 to 100,000 lb. per sq.in. These are remarkable values, and it is to be regretted that creep data are

not available for the behavior of this material at elevated temperatures. The nickel-copper alloy containing 2.75 per cent silicon, in the cast and heat-treated condition, has tensile strengths of 100,000-125,000 lb. per sq.in. These two metals find special application in valves and pumps used in handling corrosive solutions at elevated temperatures, and in superheated steam service.

In the solvent de-waxing of lubricating oils large vessels are subjected to temperatures as low as minus 75 deg. F. These vessels are made by welding steel plates. Carbon steel in the form of plate can be fabricated commercially, but carbon steel, although retaining its tensile properties at extremely low temperatures becomes weak in impact resistance. The 18 per cent chromium, 8 per cent nickel type of steel does not exhibit this phenomenon, but it is too costly for these large structures. Recent work indicates that a steel of about 2.25 per cent nickel content has good low-temperature impact properties. Much work remains to be done in determining the best composition of this steel for optimum conditions and much exploration is needed in other low-alloy steels.

Nickel and its alloys are among the most important materials used for corrosion resistance. The 66 per cent nickel, 33 per cent copper alloy has been modified by the addition of 2.5 to 3 per cent silicon, especially for use against sulphuric acid.

Copper, the most widely used of the non-ferrous metals, owing to its mechanical weakness, has not had the wide applicability that its other properties deserve. This weakness has been greatly improved in recent years by the addition of other metals, in some cases followed by heat treatment. Silicon and manganese additions to copper are coming into use due to their desirable corrosion resistance and higher strength.

A large number of copper-silicon alloys modified by different combinations of zinc, manganese, nickel, aluminum, tin and iron are now on the market. The alloys containing 2 to 3 per cent nickel and 0.5 to 0.7 per cent silicon may be given high strength and hardness by heat treatment. A more recent development is the copper alloy which contains 1 to 3 per cent of beryllium. A tensile strength of 200,000 lb. per sq.in. may be obtained by heat treatment. Although its uses are limited, the non-sparking property, strength, and resistance to wear and corrosion make possible the use of this material for hammers and blades in grinding mills, pulpers, and mixers. Hand tools such as chisels, hammers, scrapers, and wrenches are made of beryllium-copper for use in explosive atmospheres.

Chromium is used in copper for its contribution of strength and hardness to the resulting alloy. This metal in amounts up to about 2 per cent dissolves in the copper at elevated temperatures and later is precipitated from the solid solution by heat treatment, increasing strength without decreasing conductivity to a sufficiently large degree to overcome the initial advantage of the high conductivity of copper. The availability of such copper alloys will provide a useful tool where the drainage of heat away from or the conductivity of heat to substances is useful. Another closely related development is the silver-bearing copper. It has very high thermal conductivity and retains the strength imparted by cold working to moderately high temperatures.

Lead is a favorite in the process industries. This popularity is due to the combination of chemical resistance, pliability, and good working qualities, which facilitate fabrication and repair work. Tellurium lead is a new development. It has greater tensile strength and more resistance to fatigue and corrosion than other lead alloys. Its rather brief experience indicates that for a short period this lead alloy will withstand boiling sulphuric acid, and that it very satisfactorily resists phosphoric acid, chlorine gas, impure solutions of sodium sulphite, and sulphur dioxide.

## Welding Developments

The many varieties and shapes of equipment in the process industries make welding an especially cheap and convenient form of construction. The two most important recent developments have been improvements of covered electrodes and the discovery of means of overcoming deterioration at or near the weld of stainless steels products.

Covered electrodes tend to prevent embrittlement of the metal that has been deposited. In addition, it provides a flux for refractory oxides formed during welding so that these oxides will not be entrapped within the fused-in metal, but will be fluxed away.

Intergranular corrosion is apt to occur in the neighborhood of welds if the metal is not heat-treated after the operation. When the equipment is very large it is not practical to give it such a treatment. Metallurgists have been at work endeavoring to eliminate this unfortunate tendency in the 18-8 alloys by slight modifications in the chemical composition. Recently, it has been found that addition of small amounts of titanium or columbium retard the susceptibility to intergranular corrosion.

The method of joining steel parts by brazing with copper or a copper alloy under reducing conditions is finding a useful application in the construction of numerous machine parts to replace riveting or bolting. It should have a useful application in the chemical industry. By this method parts to be joined are tightly fitted by being pressed into place so as to leave only a capillary space in the joint. Copper or copper alloys in the form of wire, strip or powder may be placed near the joint and heated above the melting point in a controlled atmosphere. The brazing material is drawn by capillary attraction into the joint effecting on cooling an exceptionally strong union of the parts.

The recently devised method of joining copper tubing by a butt-fitted, threadless, soldered joint has provided a soft solder that is especially effective in withstanding creep. This solder, of about 95 per cent tin, 5 per cent antimony composition, withstands a given unit stress at the joint at steam temperatures from three to five times as long as common 50 per cent tin—50 per cent lead solders. Sweated sleeve joints of solder for copper tubing have proved successful and make possible the use of thin wall tubing.

For greater strength and corrosion resistance than obtained with tin-lead solders, new silver solders have been developed. These have a comparatively high melting point, and although they are more costly than the soft solders they are required for some applications.

Raw material for an industry

# Distilling Pine Products At New Orleans

By J. B. NEALEY
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TAR, PITCH, turpentine and their derivatives are produced in the South by the dry or destructive distillation of pine wood. The still residue is charcoal, which is sold for use as domestic fuel. The pine forests of the South were the variety known as long-leaf yellow pine. They have practically all been cut by the lumbermen, but the log trimmings and stumps still remain. Lying on the ground for the past 10 to 20 years the outer portions have rotted away leaving the resinous heart. The longer this material has been on the ground the more valuable it is to the tar manufacturer.

The American Turpentine & Tar Co., Ltd., of New Orleans, La., is one of the largest pine tar distillers in the country. This company produces pine tar of various grades, pine tar oil, pine oil, turpentine, dipentene, pyroligneous liquor, and such products as Laksol and Pinetrel. Dipentene is a rubber solvent used in reclaiming rubber from old tires. Pyroligneous liquor is used to give the smoke flavor to the liquid and salt meat cures. Laksol is a fast-drying lacquer solvent. Pine-trel is an animal wound dressing, said to be in a great degree responsible for stamping out the blow-fly and screw worm epidemics.

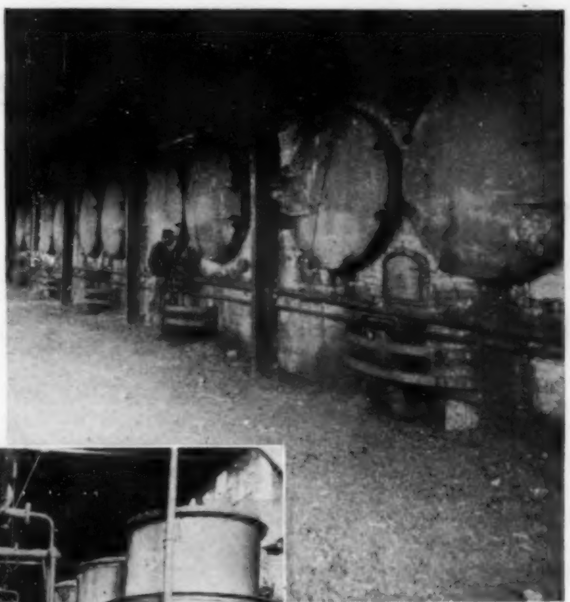
The operating procedure consists in loading pine, cut into proper lengths, into a series of 48 gas-fired retorts, which are arranged in two long rows at this plant. Each retort consists of a horizontal steel cylinder, 5 ft. in diameter and 16 ft. long, closed in front with an air-tight door. Two retorts are set into a brick furnace and a single gas burner of the venturi type serves to heat each furnace or pair of retorts. During the lifetime of this plant coal and oil have been successively employed as fuel, but gas was finally adopted as the best and most economical. A 6-in. gas header loops about the entire 48 retorts, with a takeoff at each furnace for the burner.

Originally there was an arch in each furnace as a protection against the development of hot spots in the retorts when fired with oil. Some time after the changeover to gas, these arches were removed, as no protection was necessary with this fuel and an immediate saving of 25 per cent in gas consumption resulted. The gas burners now fire against refractory walls. Today 34.6 M cu.ft. of gas does the equivalent work that formerly required 7.2 bbl. of Bunker C oil. As each cubic foot of gas contains 1,000 B.t.u. and each barrel of oil 6,200,000 B.t.u., we have:

| | |
|---|---|
| Oil | 44,640,000 B.t.u. |
| Gas | 34,600,000 B.t.u. |
| Saving | 10,040,000 B.t.u. |

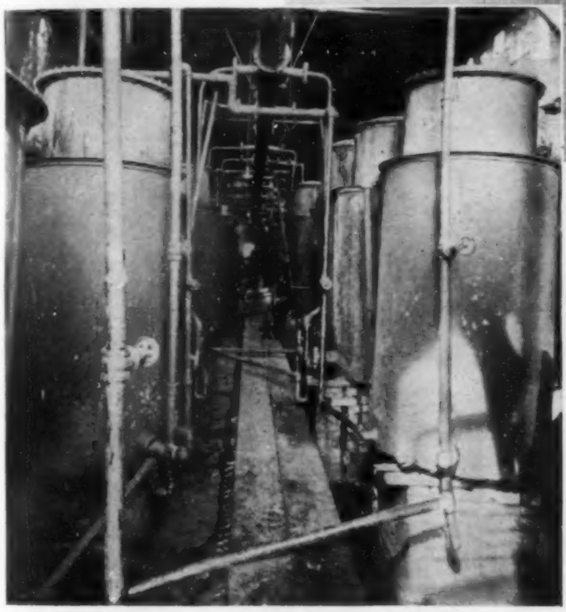
This is a reduction of 22½ per cent in heat input for the same work; by applying the current local quotations for these two fuels the comparative costs of each can be computed for any locality.

Distillation and storage section of the plant



Right: Gas-fired cylindrical steel retorts for destructive distillation

Below: Condensers, catch tubs and main for non-condensable gases



As stated, the retorts are placed in two rows, back to back with an aisle between the two rows. Down this aisle runs a 10-in. collecting header for the non-condensable gases. Vapors and gases from the distillation go over from the retort into a condenser which is water-cooled with pipe coils. The portion condensed is drained off into an open tub. Non-condensable gases are removed by the collecting header. As this gas has a heat value amounting to 500 B.t.u. per cubic foot it is used under the boilers, supplementing the natural gas used for steam power production. The condensate collected in the tubs is pumped into huge settling tanks which are made of wood to withstand the pyroligneous liquor.

When the retorts have been charged they are heated for 16 hours after which the burners are turned off. The charcoal is cooled for 8 hours before drawing and recharging. The burners are started with a gas pressure of 30 lb. and when distillation starts (after 2½ to 3½ hours) the pressure is reduced to 20 lb. It is held at this pressure until all the oils have come off (about 12 hours). Then it is again reduced, this time to 5 lb., and held there for about an hour or until the charcoal is completely dried.

Condensate collected for the first half of the run is of the lighter oils and is pumped separately from the tubs. The pyroligneous liquor, being heavier, settles to the bottom and is drained off. On the other hand, this liquor is lighter than the heavy oils given off in the second half of the run, and rises to the top in the settling tanks for the latter. Practically all of the liquor is eliminated in this way. The lighter and heavier oils, after treatment and filtration, are then recombined and pumped into pot-type stills.

There are three of these stills, each of 110 bbl. capacity, in which the oils are redistilled by means of steam coils and live steam. The light crudes containing turpentine, pine oil, dipentene and Laksol go over first and are condensed by water-cooled coils. The residue, pine tar, is pumped into tank cars, to the barreling warehouse or to storage. The condensed light crudes are agitated with sulphuric acid for bleaching and, after the acid has settled out, are again distilled, this time in a pot still with a fractionating column and in the presence of caustic soda. The distillate is divided into crude Laksol, crude turpentine, crude dipentene and finished pine oil, and these are pumped into separate storage tanks. The residue is creosote. After the soda has been neutralized by the addition of pyroligneous liquor, the creosote is sold for creosoting timber.

The crude oils are again redistilled, one at a time, in another pot still with a fractionating column. Crude Laksol distilled in the presence of caustic soda yields refined Laksol and crude turpentine. Crude turpentine yields refined turpentine and crude dipentene. Crude dipentene yields refined dipentene and pine oil.

Rosin reclamation is a separate division of this plant. Gum turpentine and rosin are obtained by notching the growing long-leaf yellow pine. The gum sap is collected, much like rubber latex, and is distilled in a pot still usually situated in the pine forest. The distillate is finished turpentine. The residue is rosin. This rosin contains sand, chips and leaves and to clean it, it is strained, while hot, through cotton batting. This batting, which after being in the strainer is known as batting dross, contains considerable rosin. Formerly this was burned or thrown away but in the process evolved by the American Turpentine & Tar Co., Ltd., it is now placed in steel tanks with naphtha. The naphtha dissolves the rosin and the solution is pumped out, leaving the dirt and cotton behind. The naphtha is then distilled off, leaving a pure rosin. The reclaimed naphtha is used over and over again.

The power plant consists of three steam boilers, two of 250 hp. capacity each and the third of 150 hp. Each is fired with a gas burner 18 in. in diameter, so equipped that it will burn either natural gas, byproduct gas or both. This is accomplished by placing the 1-in. byproduct gas nozzle inside the 2½-in. natural gas nozzle. Natural gas is delivered by a 4-in. header at 6 lb. pressure at the nozzle, while the pressure of the byproduct gas is stepped up by blower to 3 lb. Formerly coal byproduct gas and charcoal breeze were used but the natural gas has been found to be a more efficient and economical means of firing.

# Phosphoric Acid and Phosphates From Nelsonite Ore

**By FRANCIS X. FERNEY**
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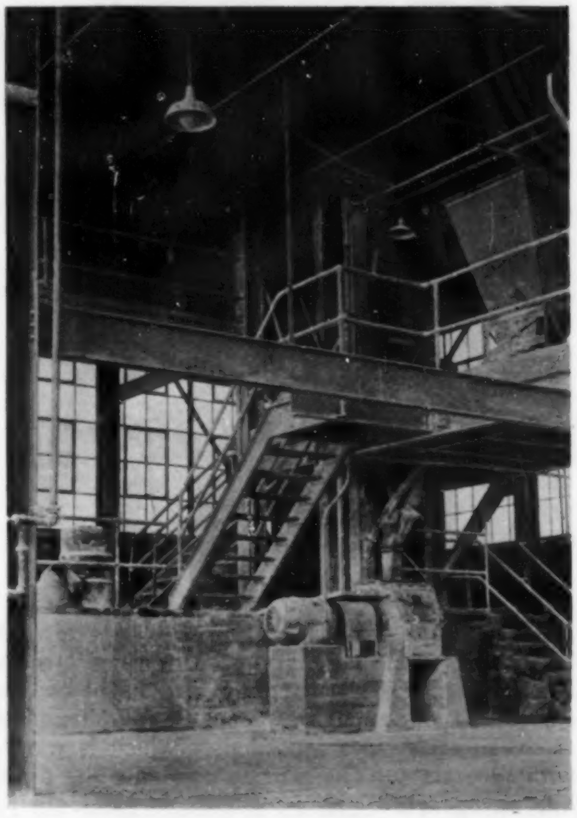
NELSONITE ORE, around which the processes of Southern Mineral Products Corp., Piney River, Va., are built, has in recent years aroused considerable interest as a source of both phosphorus and titanium compounds. It is the writer's intention to present some of the characteristics of the material in comparison with other phosphorus sources and to describe its use in the preparation of phosphorus compounds.

The name "Nelsonite" has been given to a group of high titanium-phosphorus bearing rocks of igneous origin, occurring in dikelike bodies of varying size and irregular shape in the Amherst-Nelson Counties region of Virginia. To a lesser extent they occur further southwest on the northwest slope of the Blue Ridge in Roanoke County. The name was first proposed by Thomas L. Watson in his book, "Mineral Resources of Virginia," published in 1907, for the dikelike bodies in these counties composed normally of the minerals ilmenite and apatite. The rock was named for Nelson County, Va., where it was first found.

Various types of phosphate rock and the purer phosphate bearing apatites are the principal raw materials used in the manufacture of phosphoric acid and phosphates. Bertrand L. Johnson in U. S. Bureau of Mines Information Circular 6256 defines phosphate rock as a general name applied to certain rocks of different degrees of consolidation and of diverse origins, characters, and mode of occurrence, composed of intimate mixtures of various allied amorphous or rarely crystallized phosphate minerals. The term may include phosphatized limestones, sandstones, shales and igneous rocks; amorphous nodular phosphates; residual weathered phosphatic limestones; vein phosphates and phosphate sediments both consolidated and unconsolidated.

Other phosphatic materials, not customarily considered as phosphate rock, occur in nature and likewise serve as



**Above: Grinding equipment for finished monocalcium phosphate. Right: Exterior of phosphate plant with titanium pigment plant at right**

sources of phosphoric acid and phosphates. These materials include phosphate minerals such as apatite, wavellite, guano, marls and bones. Mineralogically, the phosphate rocks consist of one or more of the related phosphates of calcium, consisting largely of tricalcium phosphate, intimately intermingled with varying proportions of other substances which may be of either organic or inorganic origin.

The many types of phosphate rock are so variable in character that no satisfactory description of them as a whole can be given. They range from soft, unconsolidated sands and gravels to hard, massive, flintlike rocks. In specific gravity they range from 2 to 3, and in color from white to coal black. In some types there is little evidence of organic origin; in others fossil teeth, bones, and phosphatic shell occur in abundance. Some types of phosphate rock contain noteworthy quantities of bituminous matter.

Phosphate raw material is valued according to its phosphorus content, expressed as tricalcium phosphate ($Ca_3P_2O_8$) and variously called tribasic phosphate of lime or bone phosphate of lime (B.P.L.). In certain instances a premium is also paid for minimum impurities, such as iron and alumina. Commercial grades contain at least 60 per cent B.P.L., though usually ranging between 68 and 77 per cent. It is of interest to note at this point that the usual run of Nelsonite apatite produced at the Piney River plant is well over 80 per cent and usually averages between 88 and 90 per cent B.P.L.

**Comparative Analyses of Various Phosphate Rocks and Nelsonite Apatite**

| | Paragon | Tennessee | Florida | Nelsonite Apatite |
|---|---|---|---|---|
| $P_2O_5$ | 36.2 | 34.40 | 32.58 | 40.88 |
| $CaO$ | 51.3 | 48.08 | 46.17 | 53.94 |
| $TiO_2$ | 0.09 | 0.12 | 0.08 | 0.05 |
| $Fe_2O_3$ | 1.06 | 2.24 | 1.02 | 0.54 |
| $Al_2O_3$ | 1.18 | 1.65 | 1.58 | 0.58 |
| Loss Ign | 0.28 | 1.96 | 4.67 | 0.08 |
| $MnO$ | 0.07 | 0.11 | 0.04 | 0.06 |
| $H_2O$ | 0.20 | 0.62 | 0.78 | None |
| $SiO_2$ | 5.87 | 6.98 | 9.80 | 2.30 |
| $CrO_3$ | 0.002 | 0.001 | None | 0.005 |
| $V_2O_5$ | 0.02 | 0.02 | 0.01 | 0.002 |
| F | 3.97 | 3.84 | 3.55 | 3.61 |
| $MgO$ | 0.17 | 0.19 | 0.14 | 0.29 |

## Composition of Phosphate Rocks

In phosphate rocks the calcium phosphates present are largely of the amorphous types, with smaller quantities of the crystalline varieties. In addition to calcium phosphates, commercial deposits ordinarily contain other substances, notably calcite, magnesite or colomite, pyrite, limonite, sand clay and organic matter. Common impurities are iron and aluminum. The former is ordinarily present as limonite, although pyrite is found in certain types of phosphate rock.

Vivianite, an iron phosphate, has also been noted at some places but is rare. Aluminum occurs both in the clays and in aluminum phosphates. Silicon occurs both as quartz sand and as silicates in the clays. Magnesium oxide probably occurs most commonly as magnesite or dolomite.

Fluorine is an essential constituent of all the commercial grades and types of phosphate rock produced in the United States. The fluorine ranges between 2 and 4 per cent and occurs chiefly as a constituent of the phosphate minerals of which the rock is composed. Some phosphate rocks contain traces of iodine, chromium and vanadium.

Phosphate rock deposits of present or recent economic importance occur in the Atlantic Coast states, in Florida and South Carolina; in the Mississippi Valley region, in Tennessee, Kentucky and Arkansas; and in the Rocky Mountain region, in Idaho, Montana and Wyoming. The

**Air view of Piney River plant of Southern Mineral Products Corp., with mine workings and ore preparation building in background, sulphuric acid plant at left and manufacturing group at center. In the latter, units from left to right are: power house; titanium pigment and phosphate plants; storage and shipping building is in foreground**

different deposits differ widely in age, structure and other characteristics.

Apatite occurs in many localities in large and in small hexagonal prisms usually of a green or red color, but sometimes violet, white or yellow. It may occur as either fluor-apatite or chlor-apatite, depending on the relative amounts of fluorine or chlorine to be found in its composition. Formerly, practically all the apatite produced in the world came from New York State, Canada, Virginia and Norway. Recently, large deposits have been exploited by the Soviet Government in Russia.

The apatite produced by concentrating the Nelsonite ore occurring in the Warwick mine at Piney River corresponds to the formula $3\ Ca_3P_2O_8.CaF_2$. It has a specific gravity of 3.2, a hardness of 5.0 and a reddish-brown coloration. The color is entirely on the surface and the apatite is perfectly white after acid leaching. The quality of the deposit is excellent and the material is much more desirable for use in the manufacture of a food-product phosphate than are the less pure phosphate rocks. The latter usually have a relatively high organic content, owing to their origin, and also a high iron and aluminum oxide content. The apatite produced at Piney River, however, being of igneous origin, has had no opportunity to acquire organic material and having crystallized out in a pure state, is extremely low in iron and aluminum oxides and other undesirable compounds often present in phosphate rock. It has the further advantage over phosphate rock of having a higher B.P.L. content as it is a purer, more concentrated form of natural phosphate.

The Nelsonite found in the Warwick deposit is of equi-granular texture and dark color, with a ratio of the principal ore minerals, ilmenite and apatite, which does not show a great deal of variation. Ilmenite is always in excess of the apatite. Average ilmenite content in the crude ore is about 45 per cent and apatite about 20 per cent. The ore deposit, which consists of a dikelike body of disseminated ilmenite and apatite in a Nelsonite formation, has been extensively drilled and from information resulting from this drilling has been divided into three sections. At the present time all operations have been confined to the northern end of the north section near which point the mill is located.

## Mining Operations

The base level on which operations are taking place is set at the same level as the mill grizzly so that a narrow-gage track from the working serves for the transportation of ore to the mill. The ore is broken by electrically exploded dynamite and loaded, on the base level, into 1-cu.yd. cars by hand and then trammed to the mill where it is weighed and broken through the grizzly.

Ore that has passed the grizzly is conveyed to a large jaw crusher, further reduced, sampled by an automatic sampler and passed on to the mill crude-ore storage bin. The sample is assayed for moisture, $TiO_2$ and $P_2O_5$ content.

Ore from the crude-ore storage bin is conveyed to the mill where it is fed into a rod mill with a certain quantity of water and there subjected to a mild grind or severe scrubbing which is sufficient to break the grains of mineral apart without grinding them to any great extent. The resulting pulp that discharges from the mill is pumped to a vibrating screen where it is sized. Oversize from the screen is returned to the rod mill for further grinding and the undersize is carried by gravity to the classifiers.

Much of the material in the pulp that passes through the screen is very fine and would interfere with the magnetic separation of coarser particles further along in the process if it were not removed at this point. The function of the classifiers is to remove this fine material. The remaining coarse material or sand is washed before leaving the classifier and then fed into a rotary dryer from which it is discharged as a hot, dry, free-running sand.

## Magnetic Concentration

The hot discharge from the dryer is next passed over a cooler and then conveyed to a storage bin. Sand from the storage bin is fed by gravity to the magnetic separator which is of the induction roll type, and more or less designed for this particular process. The separator consists of a series of rolls set in the path taken by the magnetic flux produced by an electromagnet. These rolls are made up of spaced, laminated iron rings and are so set that the flux traveling from one pole piece to the other of the electromagnet also has to pass through the roll, thereby inducing a magnetic pull in each roll. The flux densities are so adjusted that each roll from top to bottom of the separator exerts a greater magnetic pull than the one before. The rolls revolve at a moderate speed and as they are magnetized, any particle of sand which will respond to magnetism is carried part way around the roll before it is dropped, while nonmagnetic material is immediately thrown off by centrifugal force so that a separation of magnetic and nonmagnetic material may be made.

By passing the dry sand over the rolls of this separator it may be separated into three different products which are, namely, (1) a black, highly magnetic ilmenite concentrate removed by the weakly magnetic rolls; (2) a brown, micaceous, weakly magnetic tailing product removed by the strongly magnetic rolls, and (3) a granular, nonmagnetic apatite concentrate which remains when all of the magnetic materials have been removed from the sand.

The ilmenite concentrate produced may be ground for the manufacture of titanium pigments, or it may be used unground in the manufacture of ferro-titanium alloy. The tailings are stored on the tailings dump for possible treatment at a future time. Apatite concentrates are shipped to the phosphate division to enter into the manufacture of phosphoric acid. Mill samples are all taken by automatic samplers and assayed for their $TiO_2$ and $P_2O_5$ content.

Two distinct types of process are known for the production of phosphoric acid; one involves the use of heat and silica to decompose the phosphate raw material, and the other, the use of sulphuric acid for this decomposition. The former or pyrolytic process was first commercially applied about 1917; both coal and electricity are used for heating at the present time. This process is based on the fact that at high temperatures silica assumes the property of a strong acid, in so far as its ability to combine with bases is concerned. Therefore, it can displace the phosphoric acid of the phosphate raw ma-

terial, forming silicate of lime and phosphoric acid. The latter, being volatile at the high temperatures, is driven off as a fume after which it is collected by absorption in water.

The outstanding advantage of the pyrolytic process is that the bulk of the iron and alumina compounds and organic matter occurring in the phosphate raw material can be separated from the phosphoric acid. The disadvantage is that certain of the impurities, such as sulphur, arsenic and fluorine, are also volatile and contaminate the resultant acid. These impurities can be partially removed by chemical treatment, after absorption, but owing to the high concentration of the acid encountered, the removal is extremely difficult.

In the sulphuric acid decomposition, which has been used for a much longer period, the phosphate raw material is treated with sulphuric acid and the calcium is replaced by the hydrogen of the acid. Relatively dilute phosphoric acid solution is obtained. The advantages of the sulphuric acid decomposition are that the dilute solutions are much easier to handle during purification and more complete removal of the arsenic and fluorine is possible. The disadvantage is that, in the main, the iron and alumina compounds, along with the organic matter, are not separated from the phosphate and contaminate the resultant phosphoric acid.

### Processing Steps

From a consideration of the above, along with the advantages of location and raw material and an assay of the economics involved, it was decided to process the Nelsonite apatite with the sulphuric acid type of decomposition, adding certain improvements and modifications.

The process as applied involves both continuous and batch operation. Responsibility for this type of set-up can be traced both to mechanical advantages and economic expediency.

The various steps or stages in the process and the order in which they occur are: (1) leaching of the apatite; (2) grinding of the apatite; (3) recovery of phosphate in spent leaching liquor; (4) apatite reaction with sulphuric acid; (5) removal of the fluorine; (6) separation of the phosphoric acid from the gypsum and washing of the gypsum; (7) removal of the arsenic; (8) adjustment of the weak phosphoric acid so as to remove sulphuric acid or calcium; (9) concentration of the weak phosphoric acid; (10) bleaching of the strong acid; (11) settling to remove gypsum crystallized during concentration.

The apatite leach can be carried out either as a separate step before grinding or combined with the grinding operation. If it is preferred to carry out the leaching and grinding as a single step, the apatite (40 mesh) is fed direct to the ball mill and the leaching liquor (10 per cent phosphoric) used as a grinding medium. The grinding is carried out in the usual ball mill with silex brick lining over lead lining, and charged with Danish pebbles. Specific gravity of the slurry should be held between 1.5 and 1.6 and retention adjusted so that the discharged ground apatite entirely passes through 100 mesh with at least 90 per cent through 200 mesh. Discharging from the ball mill, the slurry is fed direct to a continuous drum filter, equipped with nitrated cloth as the filter medium, preferably wound with KA2M wire. Incidentally, KA2M is by far the best material we have found to resist the corrosive action of the phosphoric acid, regardless of strength or temperature.

The filtrate (spent leaching liquor) is returned to storage for phosphate recovery and the solids repulped with 20 per cent phosphoric acid and fed to the reaction tanks.

If the apatite is leached coarse and then ground, 20 per cent phosphoric acid is used as the grinding medium, with the ball mill discharge feeding direct to the reaction tanks. As a general thing it has been found that the coarse leach is the preferred practice.

After the apatite has been leached and ground it is fed as a slurry to the reaction tanks where it is decomposed with sulphuric acid. These tanks consist of a series of three with the overflow from the first flowing into the second tank and the overflow from the second into the third tank. The tanks have a volume of about 5,000 gal. and are lead lined, with silex brick lining over the lead. The agitators are made of wood or of cast KA2M.

All feeds are into the No. 1 tank. The feeds, apatite, sulphuric acid and dilute phosphoric (20 per cent) are so adjusted and controlled that the acid strength remains at about 35 per cent phosphoric acid in the No. 3 tank, with less than 0.5 per cent excess sulphuric acid. At this strength it is necessary that the temperature in the No. 3 tank remain below 190 deg. F. to insure all the calcium sulphate being present as gypsum. If this temperature is exceeded or the strength of the acid allowed to increase to any extent, a portion of the gypsum is converted into the hemi-hydrate ($2\ CaSO_4.H_2O$) and this results in serious difficulty when the gypsum removal step is reached.

It is desired that the acid always carry a slight excess of sulphuric acid so as to insure maximum recovery. About 80 per cent of the reaction is completed in the No. 1 tank and better than 90 per cent in the first two. An average conversion of better than 98 per cent is to be expected.

### Purification

Precipitation of the fluorides is also carried on in these tanks. The soda necessary for this precipitation is supplied as sodium phosphate and is part of the diluent entering the No. 1 tank. The next step in the process is the separation of the gypsum in the slurry discharging from the No. 3 tank. This separation and washing of the gypsum can be accomplished either by countercurrent decantation, by a series of continuous drum filters, or by a combination of both. Each of these three set-ups will perform satisfactorily and it is debatable which is superior. The washing of the gypsum in any case should be such that at least 95 per cent of the phosphoric acid is removed. The dilute phosphoric acid (10 and 20 per cent) used for leaching and repulping or as the grinding medium may be a portion of the washings from the filters.

If filters are used they should be of acidproof construction with nitrated cloth as the filter medium.

It is of interest to note that the gypsum produced by decomposition of Nelsonite apatite with sulphuric acid is of such whiteness that it makes a very commendable extender for pigment; in fact the whiteness is equal or

superior to the gypsum produced by reacting the best grades of lime with sulphuric acid.

The weak phosphoric acid after being separated from the gypsum is next sulphided for arsenic precipitation. Sulphide may be added as the sodium salt. While the arsenic sulphide is coagulating, the weak acid is analyzed for free sulphuric acid or monocalcium phosphate as the case may be and the quantity of lime or acid necessary for complete conversion to gypsum is calculated and added. After this addition the acid is agitated for 30 minutes and again filtered. The filtrate is pumped to the evaporator storage tanks and is ready for concentration.

Concentration is accomplished in vacuum evaporators of about 500 gal. capacity, suitably trapped to prevent loss of phosphoric acid through the aspirator. The evaporators are heated with horizontal tubes having a heating area of about 200 sq.ft. The acid is fed continuously to the evaporator so as to maintain a constant level. It is of course necessary that the tubes remain covered during the concentration. Evaporation is continued until the acid reaches a strength of from 70 to 72 per cent, when it is pumped to the strong acid storage tanks.

After prolonged use the tubes become covered with gypsum and some silico fluoride ($Na_2SiF_6$) which crystallizes from solution during evaporation and it is necessary that the coating be removed to keep the evaporator at a suitable operating efficiency.

Probably the most important single development which was successfully applied to the phosphoric acid process at Piney River was that which involved the removal of all color from the acid so as to permit making a water-white sparkling product for conversion to phosphates.

### Discoloration Chemistry

To explain how this was accomplished it is necessary to bring out the detailed chemistry which the discoloration involves. The color in phosphoric acid produced by the sulphuric acid process is of two types, organic and inorganic. The organic may be naturally occurring or introduced in process, as grease, pump packing, and so on. Inorganic discoloration is usually caused by vanadium, chromium and, at times, molybdenum. These elements either occur naturally or are reduced in process to their lower oxides. In all acids which the writer has encountered it has been one or usually a combination of several or all of these substances which was responsible for the color present in the acid.

Organic discoloration is easily destroyed by oxidation. Inorganic discoloration is removed less readily. The salts of the lower oxides of vanadium, chromium and molybdenum give highly colored solutions, usually green or bluish-green, the color increasing with the concentration of these elements. As little as 0.10 per cent of either element or their combination imparts a decided color to the acid. On the other hand, salts of higher oxides, $V_2O_5$, $CrO_3$ and $MoO_3$, produce colorless solutions unless the concentration is increased to more than 1.00 per cent, when they begin to show a slight straw-color in solution. (The calcium and sodium salts of these oxides are practically white.)

To effect the oxidation of these elements to their higher oxides it is necessary that the acid be practically free from chlorides. This excludes chlorates or perchlorates as the oxidation medium; in my opinion the only satisfactory medium is permanganate.

Since chlorides are frequently present in the raw phosphate material, displacing a certain portion of the fluorine, it is necessary that these be removed. This removal can be carried out to a satisfactory extent by treatment of the weak acid with permanganate and by maintaining a permanganate excess during concentration. This will effectively remove the chlorides as chlorine.

It is also chemically feasible to precipitate the naturally occurring chlorides as silver chloride, using silver sulphate as the precipitating medium. In this case the silver chloride would be recovered with resultant conversion to silver sulphate for reuse.

The strong phosphoric acid, after being properly bleached, is pumped to the settling tanks where the salts which crystallized from solution during concentration are allowed to settle. This usually takes from 12 to 20 hours. After settling the acid is ready for conversion to phosphates.

### Monocalcium Phosphate Production

At the present time the entire phosphoric acid production is being converted to monocalcium phosphate. This particular salt is in especial demand in the district in which the plant is located.

Monocalcium phosphate is the foremost acid ingredient used in the manufacture of baking powder and self-rising flour. It was first used as a food product in 1856 when Eben Norton Horseford took out a patent for its preparation for use in baking powder. Self-rising flour was not compounded until early in the 20th century.

Monocalcium phosphate is prepared by mixing carefully measured quantities of high grade lime with phosphoric acid. Extreme care is used in the selection of the lime and only that of highest purity, 99 per cent and higher, is considered suitable for use. In the mixer, a type developed at Piney River to assure maximum uniformity of product as regards neutralizing strength and texture, approximately $\frac{1}{2}$-ton batches are mixed for a 2-hour period and dumped as a semi-dry powder containing about 2 per cent moisture.

The monocalcium phosphate, after dumping from the mixer, is shoveled into trays and further dried in a shelf vacuum dryer. The usual drying period is about 2 hours so that a consistent cycle is maintained with the mixer. Larger tonnage operations would probably indicate a rotary vacuum dryer as preferable for this operation. After proper drying the phosphate is further aged for from 3 to 6 days, when it is ready for grinding and screening.

Grinding is accomplished in a hammer mill and screening with rotary screens. Extreme care is necessary in the screening operation as a definite range of particle size is required by the users. All dust accumulated in the grinding and screening operation is, therefore, returned to the mixer.

Properly ground and screened material is packed in burlap bags lined with paraffined liners, 150 lb. to the bag, and warehoused. From this point it is ready for shipment. All monocalcium phosphate produced at Piney River is being consumed by the self-rising flour industry and shipment is usually made by truck.

# Hydrometric Nomographs for Acetic Acid Solutions

By D. S. DAVIS
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CHEMICAL ENGINEERS and chemists who find themselves confronted with the problem of designing and maintaining a rapid and reasonably accurate method for the determination of the concentration of acetic acid will naturally turn to hydrometric means. This is particularly true if the test is for control purposes and is to be made at short intervals by an operating man.

Good hydrometers are readily available and these, together with temperature readings, supply sufficient data from which the desired concentration may be estimated. In place, however, of the somewhat cumbersome tables of specific gravities corresponding to various percentage compositions at temperature intervals of 5 deg. C. the accompanying line coordinate charts will be found to be helpful. They permit the concentration to be read for any temperature between 10 and 30 deg. C. and perform graphically the interpolations which would otherwise have to be handled numerically.

The first chart, Fig. 1, which covers the range between 0 and 30 per cent acetic acid, is predicated upon the following relationship between $\delta$, the specific gravity, and $t$, the Centigrade temperature:

$$\delta = a\,(t + 0.00667\,t^2) + b$$

where $a$ and $b$ are constants specific for each value of the concentration.

The dashed line indicates that a sample of acetic acid with a specific gravity of 1.034 at 17 deg. C. contains 25.0 per cent $CH_3COOH$.

The second chart, Fig. 2, covering the range between 30 and 100 per cent acetic acid, depends upon a simpler relationship between specific gravity and temperature:

$$\delta = a\,t + b$$

It is interesting to note in this higher range that a single value of the specific gravity at a given temperature may correspond to *two* concentrations. This ambiguity, inherent in the physical properties of the solution and in no way due to the methods of correlation of the data, need cause no difficulty since one usually knows from experience with the process which value to take. Thus, the broken line shows that a solution testing 1.062 at 16 deg. C. may contain either 52.0 or 96.5 per cent acetic acid.

TWO COMPANIES, duPont Viscoloid Co. and the Fiberloid Corp., have recently been reported to be producing cellulose ester sheeting for safety glass interlayers by new extrusion processes. Previously such sheeting was made by cutting individual sheets from blocks. The new processes are said to reduce waste and to yield products that are superior in both clearness and cleanliness.

**Fig. 1—Densities of 0-30 per cent acetic acid**

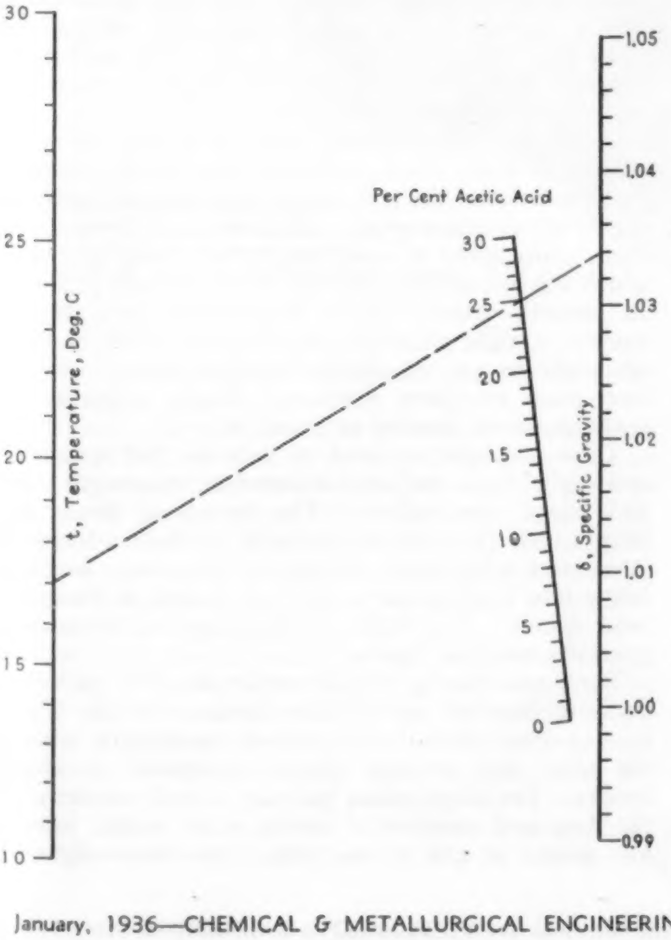
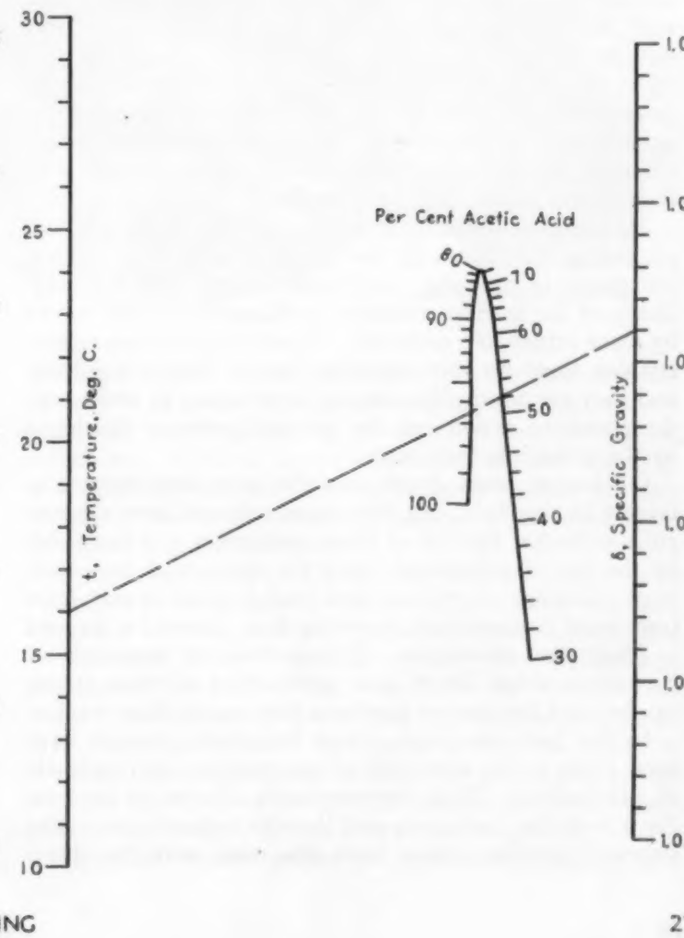



**Fig. 2—Densities of 30-100 per cent acetic acid**



# Returnable Drums For Handling Chemicals

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**By R. W. LAHEY**
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THE LAYMAN'S IMPRESSION of a container is an outer covering or package which protects the product from the abuses of handling and transportation. This viewpoint, although true for the ordinary container, is far from correct for heavy returnable drums. These drums are combating destructive conditions on all sides, similar to a surrounded army being attacked from front, rear, both flanks, and traitors in its midst. From the outside they are attacked by the excessive abuses encountered in transportation and handling, by corrosion due to constant exposure to the elements and continual exposure to the destructive fumes encountered around chemical plants. From the inside they must contend with both chemical and physical attacks.

Heavy gage returnable drums are the "cure alls" of packaging difficulties in the chemical industry. Where the going is roughest, returnable drums lead the way. Many of the hardest container problems have been solved by these returnable packages. Their rugged construction enables them to withstand extremely rough handling, and they are admirably adapted structurally to resist both the corrosive action and the internal pressure developed by the chemicals they carry.

Of course, steel drums are the most important containers in this field, but the manufacturers have successfully extended the use of these containers to other fields by the use of galvanized, pure tin, terne, and lead coatings. Linings of rubber, and lead bonded drums have been used to transport materials that cannot be shipped in plain steel containers. Drums made of aluminum or chromium-nickel alloys have possibilities as these metals can be used for certain products that attack plain steel.

In the last few years, many important changes have been made in the materials of construction and methods of fabrication. These improvements all tend to increase the life of the containers and thereby reduce costs. The shippers' problems have been discussed with the drum manufacturers through the Steel Barrels and Drums Committee of the Manufacturing Chemists' Association. Thomas P. Callahan (Monsanto Chemical Co.), chairman; Maurice F. Crass (Grasselli Chemical Co.), Douglas J. Stewart (E. I. duPont de Nemours & Co.), Colonel G. E. Carleton (Bureau of Explosives) and W. B. Sherry (General Chemical Co.) have pioneered in this work, and it is largely through their efforts that these improvements have been made. The industry is indebted to these men, as their efforts have resulted in increased safety and lower costs.

There are many different types of service which the returnable drum must withstand, due to the differing characteristics of the materials carried and the service to which the drums are put. As a result of these conditions, many types of construction have been developed which will best fit the conditions of one or more products. In general, drums can be divided into two classes; namely, straight sided and bilged types. Each of these are made in varying details of construction, such as three-piece, two-piece, reinforced chimes, rolling hoops, openings, metal, coating or lining, etc.

These packages are made in both the full open head and "tight" type, and are fabricated in the straight-sided and bilged construction. The open-head drums are largely used for solid or semi-solid products. Nitrocellulose wet with water or alcohol, pigments, lacquers, heavy oils, food products, etc., are packed in the open-head drums. The tight- or bung-opening drums are generally used for liquids.

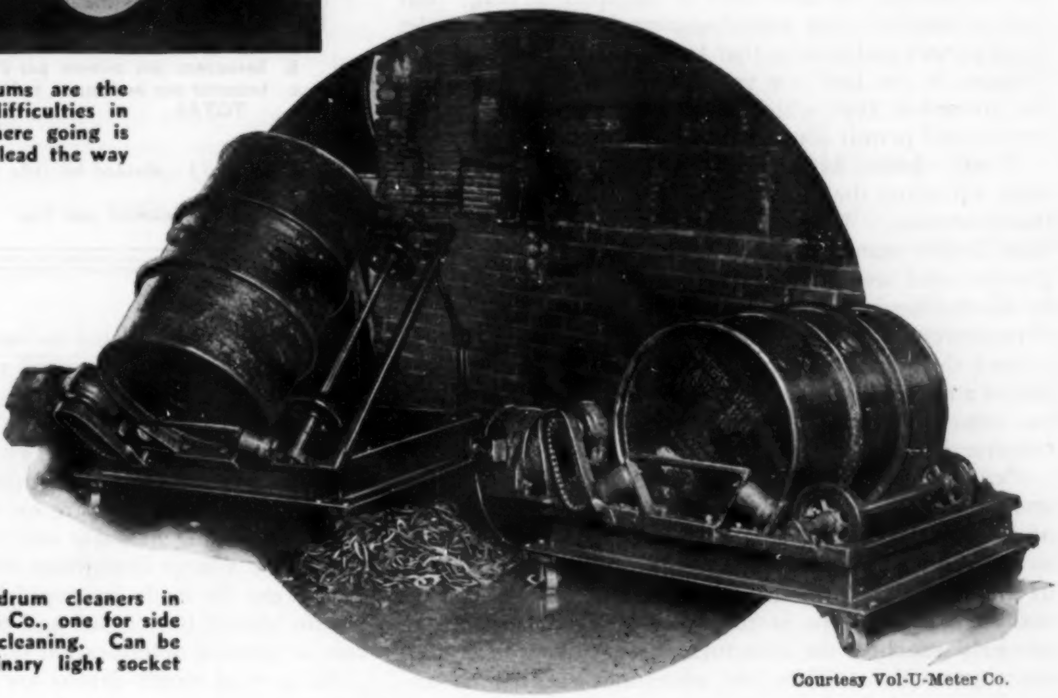
There are advantages in the constructions of the bilged and straight-sided types. Manufacturers of the bilged type of drum claim that the arched construction stiffens the sides and provides greater resistance to severe knocks. The bilged shape has only a small contact with the floor and therefore it can be easily rolled, turned, and placed on end by one man. The tare weight of

**Heavy gage returnable drums are the "cure alls" of packaging difficulties in the chemical industry. Where going is roughest, returnable drums lead the way**

lieve that the gross weight is approximately 1,880 lb.—a load much too heavy for safe and economical handling unless mechanical equipment is available.

The quality of the steel used in drums is of much importance, for it is obvious that any container which must resist these stresses and strains, internal pressure, and corrosive action must be constructed of "perfect metal." Drum manufacturers for years were forced to use steel not suited for fabrication into drums because the old type of hot-rolled, blue-annealed sheets, rolled on the so-called hand mills, had an appreciable quantity of scale rolled into the sheets, and contained other imperfections. The adoption of the continuous rolling mill process has provided sheets having superior mechanical and welding characteristics, and sheets that have a relatively clean surface, free from any objectionable amounts of surface oxides. This process also has made possible rolling of sheets of more uniform gage.

Generally, drums are made by rolling and welding



**Two portable inside drum cleaners in plant of Niagara Alkali Co., one for side and the other for end cleaning. Can be operated from an ordinary light socket**

Courtesy Vol-U-Meter Co.

bilged containers is less than that of the straight-sided type.

Points of superiority claimed by manufacturers of the straight-sided type with the I bar rolling hoops are that these drums are easy to roll and they can be placed on end readily as the rolling hoops extend $1\frac{1}{4}$ in. to $1\frac{1}{2}$ in. beyond the shell. The rolling hoops absorb shocks without transmission to the drum shell and therefore it is claimed that lighter gaged metal can be used in the shell construction.

Heavy returnable drums are made in sizes up to and including 110 gal. The 55-gal. size is increasing in popularity, whereas the larger sizes are rapidly losing favor. This trend is due to the fact that shippers are gradually realizing that both costs and accidents are much higher in the handling and shipping of the large drums. Consider the weight of a 110-gal. drum filled with 66 deg. Be. sulphuric acid—it may be hard to be-

rectangular sheets into cylinders. Heads are simultaneously applied by double seaming or welding at each end, and then reinforcing chime rings are pressed or rolled on. Rolling hoops are attached and openings welded or pressed in. The openings or fittings are fastened into heads and bodies by oxy-acetylene welding or by mechanical die stamping.

One manufacturer cold draws circular sheets with hydraulic presses into seamless cups. They are heat treated to remove stresses, and then further drawn, and cut to size. These seamless cups are then welded circumferentially around the center of the shell of the drum. It is generally understood that the metal must be free from laminations and imperfections in order to withstand the drawing operation. Drums made in this manner have the advantages of no chime seam. This permits more thorough and inexpensive cleaning.

There are several points of importance in the manu-

facture of returnable drums which should have the consideration of the user and should possibly be included in the purchase specifications.

*Steel*—The steel used in the drum shell and head must be free from cracks, slivers, laminations, blisters or depressions in the surface.

*Welding and Brazing*—This operation is probably the most difficult to control and depends upon the proper supervision and skill of the operators. Welding technique has made considerable progress in the last few years, but the operation must be constantly watched for proper penetration, porous welds, and burnt metal. Special progress has been made in electric and acetylene welding processes and this is reflected in containers.

Some manufacturers believe that brazing makes a more homogeneous joint. The user must be sure that the product will not react with the brass joint.

*Spuds and Plugs*—In a majority of cases the spud is the first part of a drum that fails. There are two important factors at this critical point; the first is welding, and the second, the steel used in the spud or plug. Bar stock is used by some manufacturers, but others consider it too porous and believe that forged steel is much better. Changes in the last few years have provided flanges of the pressed-in type which are amply strong, give equal service and permit complete drainage.

*Heads*—Joints between the drum heads and shells must withstand the majority of the bumps and abuses of transportation. The regular three-piece drum has the head double seamed, and a sealing compound of animal glue or other semi-plastic material is used to fill crevices. In some drums the heads are joined to the shell with a circumferential weld. A reinforced ring is then pressed around the joint to supply rigidity. One manufacturer makes a two-piece drum by cold drawing the steel to form two cups which are welded together. Advantages of this construction are obvious.

*Rolling Hoops*—The hoops are for ease in handling and protect the shell of the drum against the hazards of transportation. They are of two types: first, the swedged or rolled-in type, which is merely an expanding of the shell to form a "U" shape. The second and really important type is the I-bar hoops. If they are properly attached, the structural strength serves as adequate protection. They are sometimes secured by expanding the shell of the drum on each side of the hoop. Another method is to weld retaining plates which extend over the flange of the I bar to the drum shell. These plates may be welded to the I bar itself. Recently some drums have been made with the I bar completely welded to the drum.

Both methods have certain disadvantages. The depressions in the interior of the drum, resulting from expansion of the shell, prevent complete emptying of contents. Corrosive action may result from the small amount of product left in the "empty" container. Welding overcomes this difficulty, but if it is not perfect, the structural strength of the drum shell may be damaged.

*Miscellaneous*—The interior of the drum should be so shaped that complete drainage can be obtained. Any crevices in the chimes or depressions in the shell of the drum at the rolling hoops or at the spud will prevent proper drainage. The drum which cannot be entirely emptied is not only unsatisfactory to the customer, but the dangers of deterioration of the drum through the

**ESTIMATED COSTS**
**RETURNABLE vs. SINGLE TRIP DRUMS**

| | Returnable Drums | Single Trip Drums |
|---|---|---|
| 1. Depreciation | .......** | .......* |
| 2. Repairs & Maintenance & Cleaning | ....... | ....... |
| 3. Transportation costs on the weight for average haul | | |
| Outgoing | ....... | ....... |
| Return | ....... | ....... |
| 4. Billing & Accounts | ....... | ....... |
| 5. Stock Records | ....... | |
| 6. TOTALS | | |
| 7. Less salvage value single trip drum | | ....... |
| 8. Total per trip cost | | |

**OTHER RELATED QUESTIONS**

A. Comparative safety of product
B. Appearance
C. Customer's reaction to deposit on returnable drums
D. Comparative convenience to shipper and customer
E. Other advantages and disadvantages

*Cost of new drum

**Depreciation per trip should be estimated as follows:

1. Add:
   a. Delivered cost of drum ........
   b. Insurance per annum per drum ........
   c. Interest per annum on half of drum cost ........
   TOTAL ........
2. Total of (1) divided by (life of drum in years x trips per year)
3. Equals depreciation per trip

corrosive action is liable to have serious consequences.

The appearance and general mechanical characteristics of returnable drums invite misuse by the user as they appear impregnable to abuse. Their life is directly dependent upon the treatment which they receive. It is a common practice at most chemical plants to store returnable drums where they are exposed to the weather and perhaps standing in water and mud for weeks at a time. If there is a large investment in returnable containers, a saving can be made by supplying under-cover storage. Drums should be scraped and painted at frequent intervals to prevent deterioration on the outside.

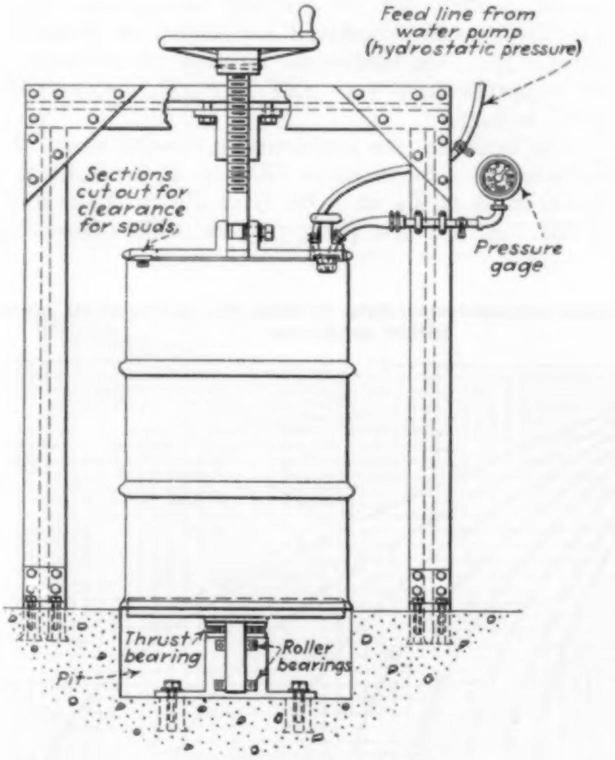
As soon as empty drums are returned they should be inspected, cleaned, repaired, and bungs greased and made tight. Adoption of this routine will insure a minimum rate of deterioration while the containers are at the owner's plant. This maintenance and upkeep is no greater than most managements give their other important assets, such as buildings and machinery. In fact, drums need more careful attention as they spend so much of their life in the hands of others.

Open-head drums are easy to clean as the complete interior of the containers can be readily reached. The problem therefore is to find a cleaning compound which will dissolve or loosen dirt and other foreign materials remaining in the barrels. The more difficult problem of cleaning tight drums is customarily solved by first loosening the scale and dirt with metal chains or balls. This is accomplished by revolving the drum. After this operation caustic soda or some other cleaning compound is used to remove the dirt. There are many types of cleaning machines on the market which revolve the drums on different planes. Each situation must be studied and

the best type of equipment available for the particular problem chosen.

Dents may be removed by the use of air pressure. From 10 to 45 lb. of air are introduced through a special plug which connects with an air hose. The drum heads must be supported to prevent bulging. The accompanying illustration was supplied through courtesy of the Draper Manufacturing Co. As drums are constructed for shipping containers, not pressure vessels, it is necessary to have this operation supervised by men who have the proper technical and practical knowledge. This is extremely important as neglect of these precautions may result in serious accidents.

Every shipper must choose between returnable drums and one-time shippers for transporting products. This question is usually approached with reluctance, as it involves dealing with many intangible items which must be evaluated both in terms of cost and convenience to shipper and customer. The problem can be correctly solved, however, if the shipper will take the time and make the effort to conduct a thorough investigation. No general rule can be followed for the answer depends on such questions as the character of the product, whether a large number of small shipments or a small number of larger shipments will be made, whether the average haul is relatively short or long, etc. Each product must be studied separately and for your guidance a suggested form is presented which when completed should clearly show what type of container will best serve the purpose. There are some border line cases where it may be hard to choose between the returnable and single-trip containers, but in the majority of instances the choice will be clearly indicated by the facts.




**Drum Dedenting Machine**

The rate of depreciation on the returnable drum may be difficult to determine, particularly as this question must be decided before any shipping experience can be obtained. It is not as hard to estimate this cost as it may at first appear for returnable drums have been used for many years in a great variety of services such as acids and alkalis, flammables, and harmless articles, A good idea of the probable life can be obtained by using as a basis for your estimate the experience of returnable drums in a service which closely approximates that of the new product. For instance, the life of drums in sulphuric acid (66 deg. Be.) service is from one to three years, in nitrocellulose cotton wet with alcohol from ten to fifteen years, flammable liquids ten years and up, aqua ammonia (26 deg. Be.) ten to twenty years, etc. Returnable drums vary in life, depending on their construction and ruggedness and the treatment which they receive, and this must always be considered in estimating life. It is also necessary to estimate the average number of trips per year which a drum will make. This does not need elaboration.

The details of the available types of full open-head and bung drums is a story in itself and will be presented at a later date.

## Amended Regulations

Regulations for the transportation of certain explosives and other dangerous articles have been amended by the Interstate Commerce Commission order No. 3666, the amendments to be effective March 20, 1936. Many changes have been made but space permits mentioning only a few of the most important.

Superseding and amending par. 208(b), order of May 12, 1930, to read as follows: Carboys previously used for the shipment of corrosive liquids when presented to carriers for transportation in carload or less-than-carload shipments as "empty" carboys, must be thoroughly (completely) drained. [See par. 201(h.)] Whenever practicable they should not be loaded in car containing valuable or perishable freight.

Packaging chlorosulphonic acid—amending order May 12, 1930, as follows: Add 366. Chlorosulphonic acid must be packed as follows: In metal barrels or drums, specification 5A; Or in wooden boxes, specification 15A, 15B, 15C,

16A, or 19A, with inside containers which must be: Glass or earthenware, not over 1 gallon each, except that inside containers up to three gallons are authorized when only one is packed in each outside container;

Or in wooden barrels, specification 11B, with inside glass or earthenware containers not over 2 gallons each;

Or in tank cars, specification 103A. (Use of one special glass-lined tank car for test service is also authorized by Interstate Commerce Commission's order in No. 3666, dated September 4, 1935, as an addition to par. 351.)

Superseding and amending par. 462(c), order June 27, 1931, to read as follows *(exemption from regulations)*:

Cyanides in tightly closed glass, earthenware, or metal inside containers, not over one pound each, securely cushioned when necessary to prevent breakage, and packed in outside wooden or fiberboard boxes, or in wooden barrels. Net weight of cyanides in any outside container, not over 25 pounds.

# Calculation Methods For High Pressures

**IN RECOGNITION of his record of creative activity in modern chemical engineering Professor Warren K. Lewis, Massachusetts Institute of Technology, has received the Perkin Award for 1936. Presentation was made at the Chemists' Club in New York, on January 10, by the American Section, Society of Chemical Industry. In reply to the introduction by Dr. G. A. Burrell and the presentation by Professor Marston T. Bogert, the medalist addressed the Society on "Application of Physical Data to High Pressure Processes."**

**As has long been recognized, use of the perfect gas laws at high pressures may lead to errors as high as several hundred per cent. Fortunately, as Professor Lewis explained, and as we have shown below in condensed form, simple methods are now available whereby dependable approximations can be made for all gaseous substances, regardless of temperature and pressure.—Editor**

WARREN K. LEWIS

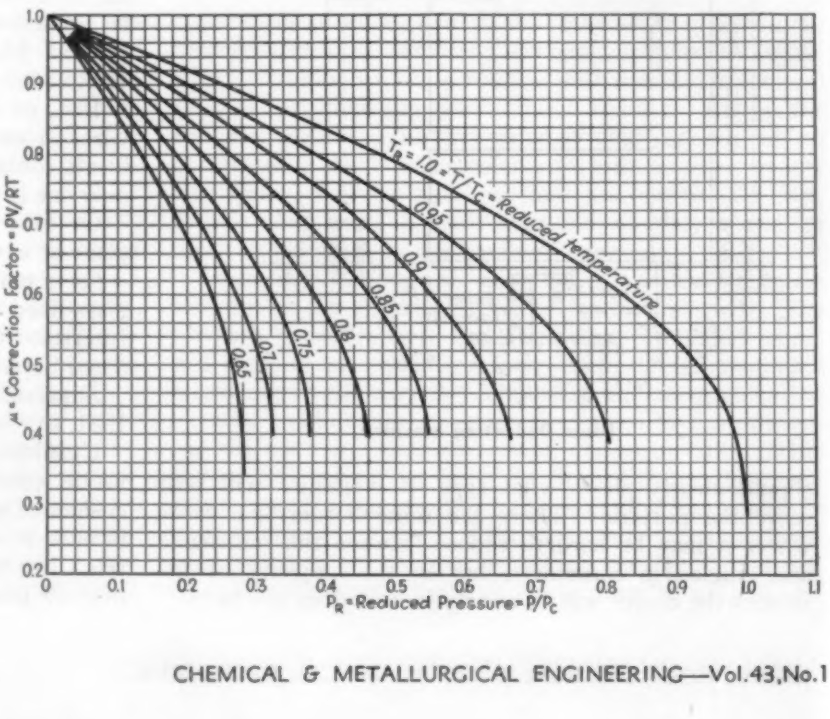
UP TO moderate pressures, frequently as high as several atmospheres, the gas law equation, $PV = nRT$, is a convenient and quite dependable approximation. But it breaks down at higher pressures and may cause errors of several hundred per cent. If, however, one will introduce into this equation a correction factor, $\mu$, the equation becoming $PV = n\mu RT$, the term, $\mu$, can be evaluated graphically from a knowledge of the critical pressure and temperature of the compound in question, by use of Figs. 1 and 2. Although these charts were derived for higher hydrocarbons and are not exact for other materials, they offer an excellent general approximation for all known substances, the deviations frequently being less than 5 per cent and rarely, if ever, greater than 15 to 20 per cent.

In illustration, calculate the volume of 1 lb. of steam at 3,500 lb. pressure and 770 deg. F. For steam, $P_c =$ 3,226 lb., and $t_c = 706.1$ deg. F. (See p. 34 for table of nomenclature.) Hence, $P_R = 3{,}500/3{,}226 = 1.085$ and similarly $T_R = 1.055$. From Fig. 2, $\mu = 0.58$. Hence, $V = n\mu RT/P$ $= 0.1113$ cu.ft. per pound, in comparison with the value 0.1187 given by the steam tables of the American Society of Mechanical Engineers. The ordinary gas laws (*i.e.*, $\mu = 1$) give 0.192.

Certain familiar relationships based on the gas laws, which break down outside their range of applicability, are rendered universally valid by substituting in them for the pressure the so-called fugacity, *i.e.*, the pressure corrected for deviations from the gas laws. Thus, the isothermal formula for reversible work of compression, $W_T = nRT \ln P_2/P_1$, becomes $W_T = nRT \ln f_2/f_1$.

For example, the isothermal reversible work of compression of 1 lb. steam at 770 deg. F. from 1,000 lb. to 3,500 lb. is at $T_R = 1.055$ from $P_R = 0.310$ to $P_R = 1.085$. At the first point $f/P = 0.905$ (from Fig. 3)

**Fig. 1—Pressure-volume-temperature relations for hydrocarbons below critical conditions**



and at the second, 0.68. Hence, $f_1 = 905$ and $f_2 = 2{,}380$ or $W_T = RT/M \ln f_2/f_1 = 130.9$ B.t.u. per pound. This can be calculated directly from the steam tables since $W_T = \Delta H - T\Delta\phi$, giving 133.2 B.t.u. per pound, based on the best available data on the physical properties of steam. The gas law work would be 158.7 B.t.u. per pound.

## Other Applications

Similarly, using the fugacity, the mass action law for chemical equilibrium

$$K_p = \frac{P^a{}_A \ldots\ldots\ldots\ldots}{P^b{}_B \ldots\ldots\ldots\ldots}$$

becomes

$$K_f = \frac{f^a{}_A \ldots\ldots\ldots\ldots}{f^b{}_B \ldots\ldots\ldots\ldots}$$

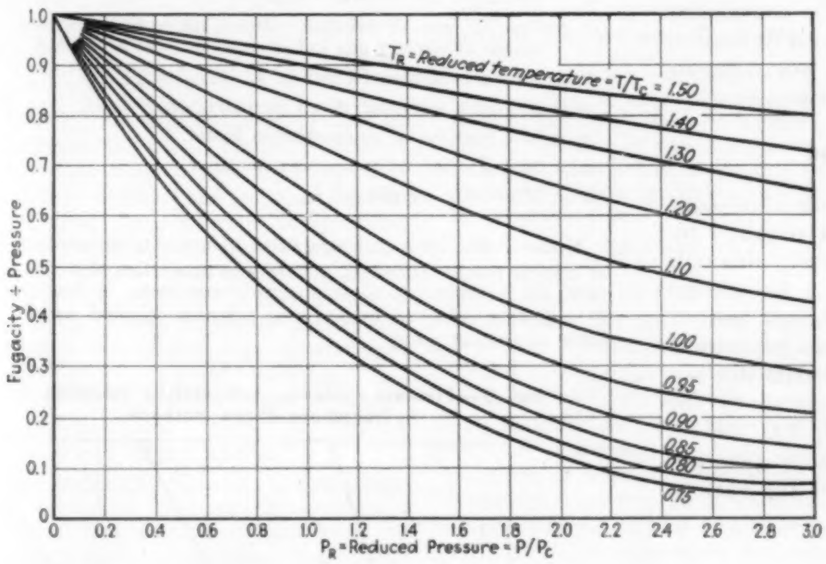
Furthermore, Raoult's law, $P_0\, x = \pi y$, becomes $f_0\, x = f\pi\, y$, and, while applying only to perfect solutions at constant temperature, is applicable in this form whatever the deviations of the vapors from the gas laws. The fugacity also can be estimated from critical temperature and pressure, using Fig. 3, the errors being even less than those involved in using the $\mu$ plots.

The internal energy and enthalpy of a pure vapor can be estimated by the equations

$$E = nM \int C_v\, dT + n\mu_c R\, T_c F \text{ and } H = E + PV,$$

where $F$ is a function only of the reduced volume given by Fig. 4. (Any consistent units may be employed in the equations, $\mu_c$ and $F$ being dimensionless.) This value of $F$ is substantially correct for hydrocarbons of four or more carbon atoms. While it may be as much as 30 or 40 per cent in error for other substances, the corresponding error in $E$ or $H$ is far less.

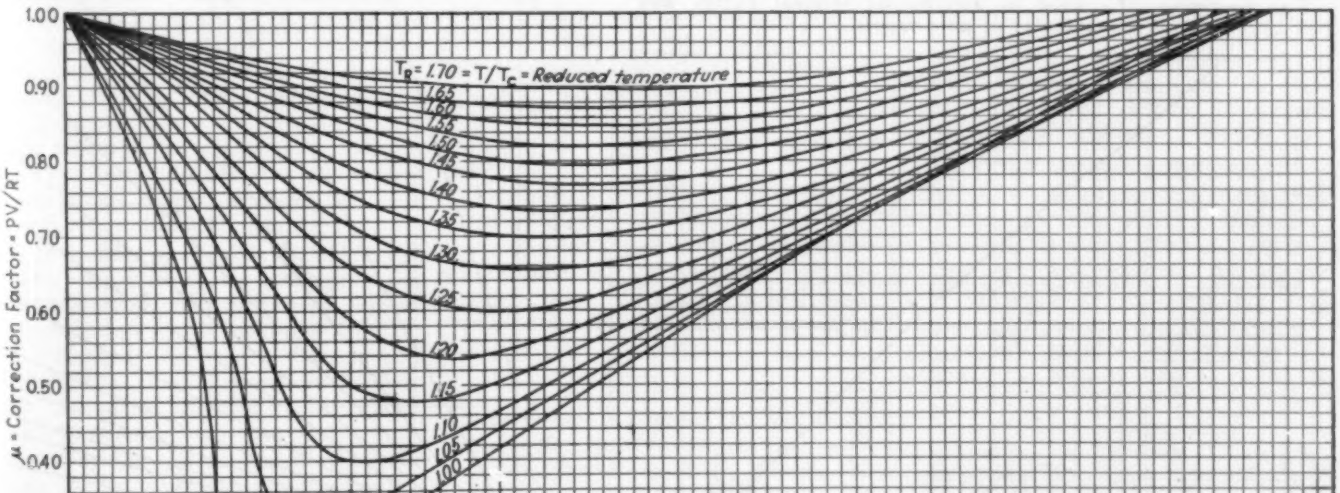
The behavior of vapor mixtures is important. Occasionally one uses Dalton's law, which states that the total pressure of the mixture is the sum of the pressures which each component would exert were it present separately. Amagat's rule that the volumes are additive on mixing at constant temperature and pressure is about equally accurate and more convenient for the solution of problems. Thus, it results in the rule that the isothermal reversible




▲ ▲

**Fig. 2. Below — Pressure - volume - temperature relations for hydrocarbons above critical conditions**

**Fig. 3. Left—Fugacities of hydrocarbon vapors**



work of compression or expansion of a mixture is the sum of the corresponding works for the individual components between the same initial and final pressures, and similarly, in the useful equation for the fugacity of a component in a mixture, $f = yf\pi$. For engineering purposes it rarely introduces errors over 15 or 20 per cent, but where necessary a precision of 1 to 2 per cent can be obtained by taking advantage of the fact that the isometrics both of the pure substances and of the mixtures are approximately straight lines and that the slope of any given isometric of a specified mixture is the weighted arithmetic mean of the slopes of the isometrics for the pure components, each taken at a molal concentration equal to that of the whole mixture. Furthermore, the negative intercept on the pressure axis of the isometric of the mixture is given by the equation,

$$\beta_m = (y_A\beta_A^{1/2} + y_B\beta_B^{1/2} + \ldots\ldots)^2 = (\Sigma y\beta^{1/2})^2$$

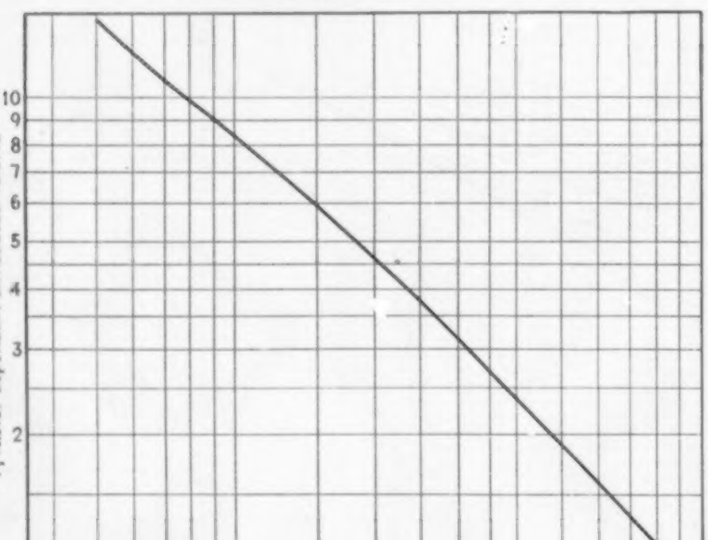
By drawing the isometrics determined as above one obtains the required pressure-temperature-volume relations.

The data of Figs. 1 and 2 replotted as $P_R$ vs. $T_R$ at constant values of $V_R$ give Fig. 5. This is convenient for estimating the behavior of mixtures as just indicated, although in that method one must use the isometrics in their absolute rather than their reduced form.

## Data Requirements for Method

No specific information regarding the individual substance, other than its molecular weight, is required by the gas laws. The rules given here, however, although still simple and direct, require in addition a knowledge of critical temperature and pressure (although not of critical volume, which can be estimated from the critical ratio, $RT_c/P_cV_c = 3.78$). Where critical data are not available, critical temperature can be estimated by the method of Watson (*Ind. Eng. Chem,* **23,** 360, 1931), and pressure, by extrapolation of the vapor pressure curve to the critical temperature by any of the various suitable methods, such as Dühring's rule.

Fig. 4—Factor "F" used in determining internal energy and enthalpy of pure vapors




## Nomenclature

$P$ = Absolute pressure, any desired units.

$T$ = Absolute temperature, any desired units.

$V$ = Total volume of gas or vapor, any desired units.

$R$ = Gas constant, preferably on a molal basis, must be expressed in units already chosen for $P$, $V$ and $T$.

$n$ = Total quantity of gas or vapor, preferably in mols.

$\mu$ = Correction factor in the generalized gas law equation, $PV = n\mu RT$, read from Figs. 1 and 2.

$f$ = Fugacity, i.e., pressure corrected for gas law deviations, expressed in same units as $P$, calculated from Fig. 3.

$\pi$ = Total absolute pressure on a gas or vapor mixture, in same units as $P$.

$P_o$ = Vapor pressure of saturated liquid in same units as $P$.

$f_o$ = Fugacity of saturated liquid in same units as $P$.

$f\pi$ = Fugacity which pure substance would possess at same temperature if it existed as vapor under pressure, $\pi$, equal to the total pressure on the vapor mixture which contains it.

$E$ = Internal energy, any desired units.

$H$ = Enthalpy, any desired units.

$C_V$ = Specific heat at constant volume, but volumes within range of perfect gas laws.

$F$ = Factor evaluated from Fig. 4.

$\beta$ = Negative intercept of an isometric on $P$ axis.

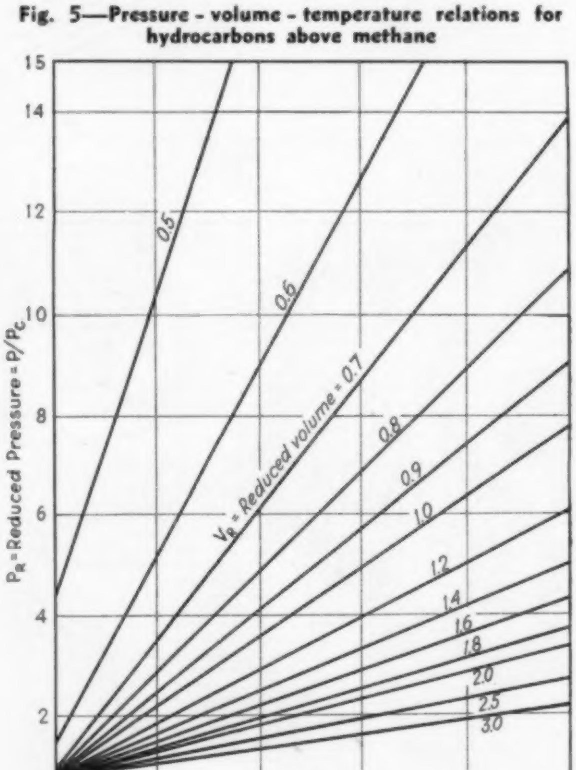
$x$ = Mol fraction of component in liquid.

$y$ = Mol fraction of component in vapor.

$M$ = Molecular weight.

**Note**—Subscript $c$ indicates value of quantity in question at critical point. Subscript $m$ refers to properties of a mixture, and $A$, $B$, etc., to those of pure components. Subscript $R$ indicates value of quantity in question divided by its value at critical point.

Fig. 5—Pressure - volume - temperature relations for hydrocarbons above methane



# Chemical Engineer's BOOKSHELF

## Rubber Reference

"RUBBER. PHYSICAL AND CHEMICAL PROPERTIES." By *T. R. Dawson* and *B. D. Porritt*. Foreword by Sir Herbert Wright. A technical handbook produced by the cooperation of The Rubber Growers' Assn., Inc., and The Research Association of British Rubber Mfrs. Published by The Research Association of British Rubber Manufacturers, Croydon, England, 1935. Cloth, 700 pages, 8½ by 11 inches. Price, 45 shillings.

*Reviewed by A. R. Kemp*

THIS BOOK, appropriately printed on latex paper, fills a long standing need for a reference work summarizing the most important scientific and technical data on rubber and its numerous compounded forms. It follows in many respects the style and arrangement used in the International Critical Tables as exemplified by Dr. G. S. Whitby's chapter on Rubber. The main text of 547 pages is arranged under such principal headings as: "Latex," "Coagulum," "Raw Rubber," "Soft Vulcanized Rubber," "Sponge Rubber" and "Hard Rubber."

The authors have in the various chapters tabulated most of the important chemical and physical data existing on rubber in its various forms. The subject index is very complete and contains nearly 7,000 items on 47 pages and the bibliography presents over 1,400 references to the literature. The most important and valuable feature of the book is the inclusion, wherever possible, of the composition of the rubber under consideration. The index of different rubber compositions covers 35 pages and lists over 3,000 rubber compounds.

The authors have made use of the excellent library on rubber built up by the Research Association of British Rubber Manufacturers which contains some 300,000 references. Messrs. Dawson and Porritt, who are both recognized for their own researches on rubber, have been assisted in their work by many other well-known rubber technologists of Great Britain. The book contains much information taken from the Association's reports and pamphlets and from various foreign sources which are not readily available to the average reader outside of that organization.

The authors and sponsors of this volume are to be congratulated for carrying through such a momentous undertaking which will be appreciated by all those interested in the science and technology of rubber. The volume should prove of great value as a standard reference work for all research workers and technologists in the rubber field.

## Furnace Design and Operation

HEAT CALCULATIONS FOR DESIGN AND OPERATION OF FURNACES (Wärmetechinsche Rechnungen für Bau & Betrieb von Oefen) by Dr. W. Heiligenstaedt, 186 pages, 13 illustrations and many tables. Published by Verlag Stahleisen, Düsseldorf, Germany, price 11.50 Rm.

*Reviewed by W. Trinks*

THIS LITTLE BOOK deserves much praise. It touches upon every engineering problem concerning furnaces in the iron and steel industry, including theory of heat, the heat balance with its various items, combustion (with space requirements for combustion), heat transfer, conduction of heat, with steady and with fluctuating temperatures, heating of the charge in furnaces, and finally heat interchange in recuperators and regenerators.

The book is very concise and is possibly too much condensed to be of quick and immediate use to the designer or operator. In spite of the care used in presenting final, usable equations, careful study is required to apply them intelligently.

The book is heartily recommended to all furnace engineers who can read German. The beginner will find a wealth of information, and the man well advanced in the profession will find chapters that bring just what he needs to round out his knowledge.

A SYSTEMATIC HANDBOOK OF VOLUMETRIC ANALYSIS. Twelfth Edition. By Francis Sutton. Revised by A. D. Mitchell. P. Blakiston's Son & Co., Philadelphia, Pa. 631 pages. Price, $10.

*Reviewed by B. H. Strom*

AMONG the most important additions to this revised edition is the section on hydrogen-ion determinations and potentiometric titration. The chapters on gas analysis have been completely revised, and much new material has been included. Publication of new methods has been prolific throughout the various sections of the volume, and the author has had the benefit of the assistance and advice of numerous well known chemists.

## Water-Gas Report

FURTHER EXPERIMENTS UPON THE WATER-GAS PROCESS. By J. G. King, B. H. Williams, and R. V. Thomas. Technical Paper No. 43 of the Fuel Research Board (British). Available in the United States from the British Library of Information, 270 Madison Ave., New York City. Price 1 shilling, net.

THIS REPORT summarizes extended investigations made during the past year and a half, or longer, by the technical staff of the Fuel Research Station on prevention of clinker and effects of rate of blowing, size of coke, nature of coke, and other factors on the performance of a water-gas generator. Some of the results are applicable only to British plant conditions, but others are directly useful to the American engineer.

OXYGEN, Its Chemical and Biological Reactions. Reports and Discussions at the 5th Council of Chemistry, *Institut International de Chemie Solvay*, held at the University of Brussels, October 3-8, 1934. 353 pages. Gauthier-Villars et Cie., Paris. 75 fr.

SIR WILLIAM POPE, president; Max Bodenstein, J. A. Christiansen, M. H. Wieland, W. P. Jorissen, W. A. Bone, Charles Dufraisse, René Wurmser, M. O. Warburg and M. O. Meyerhof presented papers or otherwise contributed to this international symposium.

CRUSHERS FOR STONE AND ORE. By *William T. W. Miller*. Mining Publications Ltd., London. 234 pages. Price 15s.

THIS VOLUME is founded on a series of articles which appeared in the following journals: *The Mining Magazine, Engineering & Mining Journal, Pit and Quarry*, and *Rock Products*. Among the types of machines discussed are jaw crushers, gyratories, rolls, disc crushers, and swing hammers. A chapter on screening has been included.

EXPERIMENTS IN ORGANIC CHEMISTRY. By *Louis F. Fieser*. Published by D. C. Heath & Co., Boston, Mass. 369 pages. Price, $2.40.

IN PREPARING this volume the author has attempted to furnish carefully standardized and detailed directions, to permit the student to acquire a good technique with the greatest pos-

sible economy of time and materials. Intelligent preparation in advance of the laboratory work has been encouraged by prefaces introducing and explaining the experimental procedure. Provision for the particularly gifted and interested student has been made by inclusion of special experiments and alternate preparations.

Dictionnaire de la Chimie et de ses Applications. By *Clement Duval, Raymonde Duval,* and *Roger Dolique.* Published by Hermann & Cie., Paris. 780 pages. Price, 90 Fr.

MORE THAN 26,000 words and terms from chemistry, applied chemical engineering, and allied subjects have been included in this volume. As the entire text is in French it will be of limited usefulness to those who do not already have a fair knowledge of this language. To such, however, it should be a valuable aid in their study of French chemical literature. The size and arrangement of the book are practical, but those making frequent use of it will probably feel the need of a more substantial binding.

Stadtgas-Entgiftung, Dr. Fritz Schuster, (Chemie und Technik der Gegenwart, XIV Band). VIII. Verlag S. Hirzel, Leipsig. Pages 167. Price, 8.80 Rm.

AN authoritative presentation of the subject of gas poisoning by a technical expert well known in the field. In addition to many technical and scientific references, the American, German, French and English patents are given.

Grundlagen der Photochemie. By *Dr. K. F. Bonhoeffer* and *Dr. P. Hartek.* Verlag von Theodor Steinkopff, Dresden-Leipzig. 295 pages, 73 illustrations and 30 tables.

THIS is the first volume to appear of a series on important chemical reactions, under the editorship of H. Mark (Vienna) and M. Polanyi (Berlin-Dahlem).

The authors, Dr. Bonhoeffer, Director of the Institute for Physical Chemistry, the University of Frankfurt a.M. and Dr. Hartek, the Kaiser Wilhelm Institute for Physical and Electro Chemistry, Berlin-Dahlem, consider systematically the material necessary for an understanding of photochemistry. The book, therefore, may serve as an introduction to this subject.

By collecting into one volume and arranging systematically fundamental work now scattered throughout the literature the authors hope to aid chemists entering this field and to stimulate and make easier the work of specialists. Absorption spectra and the behavior of excited molecules and free atoms are considered especially because of their great importance in the understanding of light reactions. However, no attempt has been made for completeness with respect to the photochemical reactions themselves. Only well investigated, representative photochemical reactions have been discussed in detail in order to illustrate the kinetics of photochemical reactions. The size of the book does not permit detailed description of experimental work and apparatus.

## Pipeline Flow

Flow of Natural Gas Through High-Pressure Transmission Lines, by T. W. Johnson and W. B. Berwald. U. S. Bureau of Mines Monograph No. 6, published and distributed by American Gas Assn., New York City. 120 pages. Price, $1.

THIS is a joint report of the Natural Gas Department of American Gas Assn. and the U. S. Bureau of Mines of an extended investigation and series of recommendations regarding measurement of transmission line flow of natural gas. The booklet reviews preceding investigations and compares the various commonly used formulas. The summary gives a recommendation as to the proper methods of measurement of flow and of calculating line capacity.

## Water Pollution

Water Pollution Research Board Report for the year ended June 30, 1935. Published by the Board (British) and available in the United States from the British Library of Information, 270 Madison Ave., New York City. Price, 1 shilling net.

THIS SUMMARY of British investigations reports studies on water softening, removal of metals from water supplies, control of factory effluents, improvements in activated sludge process, and a number of other fundamental studies, the results of which seem directly adaptable to American conditions.

Popoff's Quantitative Analysis. Third Edition. Revised by Murray J. Rice and Warren P. Cortelyou. P. Blakiston's Son & Co., Philadelphia, Pa. 555 pages.

ALTHOUGH much of the material has been rewritten and nearly all of it rearranged the revisers have endeavored to preserve the author's original idea that quantitative analysis should afford an excellent approach to theoretical chemistry. The order of presentation is Theory, Calculations, and Laboratory. However, each part is quite independent of the others. Adequate cross-references also makes it possible to use the material in any order that may seem desirable. Typical examples have been presented to acquaint the student with the function of apparatus and instruments used in analytical procedure, and much space has been given to problems and explanation of calculations.

Metallographie. Vol. II, Part 1. Edited by W. Guertler. Verlag von Gebrüder Borntraeger, Berlin. 494 pages. Price 54 Rm.

VOLUME TWO of this comprehensive handbook has been written by A. Burkhardt, with assistance of G. Sachs; the entire chapters on aluminum have been prepared by the latter. The volume treats the pure metals exclusively, and deals principally with physical and mechanical properties. Much space has also been given to the effect of the impurities commonly encountered, and their effect on the properties of the metals. The authors have presented a wealth of original material, and the book should be read with great interest by all metallurgists who have command of the German language.

## Little Life Savers

Industrial Health and Safety Series. Documents issued by the Division of Labor Standards, U. S. Department of Labor, Washington. 5 cents each.

THIS series of documents deserves wide attention among industrial executives whose employees are potentially exposed to the hazards of process industry. Each little pamphlet is suitable for distribution to members of the staff as a guide on prevention of occupational diseases. The nominal cost makes it feasible to distribute the pamphlets widely to ensure that all minor executives and foremen have available to them this reliable information.

The first nine numbered items of this series have been issued as follows: 1, Industrial Skin Diseases; 2, Anthraco-Silicosis; 3, Arsenic Poisoning; 4, Carbon Monoxide Poisoning; 5, Chromium Poisoning; 6, Mercury Poisoning; 7, Lead Poisoning; 8, Benzol Poisoning; 9, Silicosis.

A.S.T.M. Standards on Preservative Coatings for Structural Materials, Second Edition. American Society for Testing Materials, Philadelphia, Pa. 387 pages. Price, $1.75.

THE SOCIETY has brought up-to-date its standards for protective coatings, other than metallic, thus bringing together in convenient form 101 specifications, test methods and definitions developed through work of Committee D-1. Since the first edition many new standards and extensive revisions in existing specifications have been

adopted. Of the new standards 46 cover various types of pigments; 14 apply to oils and thinners; 14 provide requirements for varnish and varnish materials; 20 pertain to lacquer and lacquer materials and 10 cover miscellaneous materials.

PROCESSING THE SOYBEAN. By *O. R. Sweeney* and *L. K. Arnold*. Bulletin 103 (revised). Official publication by Iowa State College. 56 pages.

THIS bulletin summarily brings up to date much of the information available in connection with this industry. Soybean farming is discussed from various viewpoints with acreage figures for Iowa. Problems of producing soybean oil and soybean meal, together with comparative data and description of various extraction methods, are presented. There is a section on plant design including discussion of calculated operating and production costs, and a comprehensive list of references is appended.

A LIST OF BOOKS AND OTHER SOURCES OF INFORMATION REGARDING COAL AND COAL PRODUCTS. Compiled by F. R. Wadleigh, Washington, D. C. 63 pages.

LISTS books in the English language relating to coal and its principal products, together with books which, while not entirely devoted to coal, contain valuable information regarding its formation, occurrence, chemistry, distribution, and use.

LE CHAUFFAGE PAR LES COMBUSTIBLES LIQUIDES. By *A. Guillermic*. Published by Libraire Polytechnique Ch. Beranger. Paris. 384 pages. Price, 110 Fr.

HEATING by liquid fuels is the subject of this monograph. The author discusses at great length the properties of such fuels, and the common methods used in their handling and storage. Other chapters are devoted to the description of various types of burners and atomizers, automatic regulators and safety devices, and to typical industrial installations.

THE ANALYSIS AND HANDLING OF GASES. By *Augustus H. Gill*. Published by Edwards Brothers, Inc., Ann Arbor, Mich. 75 pages.

A CONCISE MANUAL of information on handling gases, including regular analytical methods, properties of gases, such as solubility, density, explosivity, and physiological action, as well as their technical uses. One chapter is devoted to the various methods of measuring gases.

CHROMIUM STEELS. By *Richard Henry Greaves*. Published by His Majesty's Stationary Office, London. 321 pages. Price 7s. 6d.

PLAIN CHROMIUM STEELS are discussed in this volume, but no attention has been given to other alloying elements frequently used with chromium, with exception of manganese and silicon which are found in practically all of these steels. The book presents a comprehensive, critical survey of published information on the history, constitution, treatment, and properties of these steels. Some material from the research department at Woolwich, which formerly has not appeared in print, has also been included. There is also an appendix which takes up the chemical analysis of chromium steels.

## GOVERNMENT PUBLICATIONS

*Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.*

*Strength and Related Properties of Woods Grown in the United States*, by L. J. Markwardt and T. R. C. Wilson. Department of Agriculture Technical Bulletin 479; 25 cents.

*Foreign Trade of the United States, Calendar Year 1934*, by Grace A. Witherow. Bureau of Foreign and Domestic Commerce, Trade Promotion Series 162.

*Regulations Under the Joint Resolution to Protect the Revenue by Regulation of the Traffic in Containers of Distilled Spirits.* Bureau of Internal Revenue Regulations 13, Revised April, 1935; 5 cents.

*Effects of Crude Oil Pollution on Oysters in Louisiana Waters*, by Paul S. Galtsoff and others. Bureau of Fisheries Bulletin No. 18; 20 cents.

*Effect of Manufacture on the Quality of Nonoily Fish Meals*, by Roger W. Harrison and others. Bureau of Fisheries Investigational Report No. 30; 5 cents.

*Synthetic Camphor.* Tariff Commission Report No. 104, Second Series; 5 cents. Relation of domestic production to consumption during six months ended June 17, 1935.

*Engineering Factors in the Ventilation of Metal Mines*, by G. E. McElroy. Bureau of Mines Bulletin 385; 25 cents.

*Flame-Arresting Limitations of Flat Joints and Plain Bearings in Explosion-Proof Mine Equipment*, by E. J. Gleim and R. S. James. Bureau of Mines Technical Paper 566; 5 cents.

*Factors that Decrease the Light of Electric Cap Lamps*, by A. B. Hooker and D. H. Zellers. Bureau of Mines Report of Investigations 3292; mimeographed.

*Recent Trends in Design and Construction of Copper Concentrators in the Southwest*, by C. E. Rork. Bureau of Mines Information Circular 6866; mimeographed.

*Bureau of Mines Multiple-Diaphragm Recording Subsurface-Pressure Gage*, by W. B. Berwald and others. Bureau of Mines Report of Investigations 3291; mimeographed. Useful in natural gas and petroleum investigations.

*Important Discoveries in Florida by U. S. Geological Survey*, by G. R. Mansfield. Department of Interior Release November 25, 1935; mimeographed. Investigations add new mineral resources to State's list.

*U. S. Geological Survey Studies Alabama Ceramic Clays*, by G. R. Mansfield. Department of Interior Release Nov. 25, 1935; mimeographed. Investigations reveal presence of high-grade kaolin and plastic refractory clay.

*Second Report of the Science Advisory Board, September 1, 1934, to August 31, 1935.* Published for the Board by National Research Council, Washington, D. C.

*United States Government Manual.* National Emergency Council, Looseleaf in large binder, monthly revisions without additional cost; $2.00. Factual information on the creation and authority, organization, and activity of all executive Government units, including organization charts.

*Annual Reports.* The customary printed pamphlets of annual reports are now available from the offices of the Secretaries of Departments and Chiefs of Bureaus or independent establishments. Those interested should write directly to the Department or Bureau from which a report is wanted.

*Technological Changes in Relation to Women's Employment*, by Ethel L. Best. Department of Labor, Bulletin of the Women's Bureau No. 107; 10 cents.

*National Resources Committee.* Reports on State Planning, a review of activities and progress, 75 cents, and on Regional Factors in National Planning and Development.

*Suggestions to Authors of Papers Submitted for Publication by the United States Geological Survey*, by Bernard H. Lane. Department of Interior unnumbered pamphlet; 15 cents.

*The Agricultural Outlook for 1936.* Department of Agriculture Miscellaneous Publication No. 235; 10 cents.

*Atlas of American Agriculture, Part 3, Soils of United States (With Bibliographies)*, by C. F. Marbut. Bureau of Chemistry and Soils (paper) $5.00, 98 pages, 3 plates, 16 maps.

*Flaxseed Production in the North Central States*, by A. C. Dillman and T. E. Stoa. Department of Agriculture Farmers' Bulletin 1747; 5 cents.

*Drug Plants Under Cultivation*, by W. W. Stockberger. Department of Agriculture Farmers' Bulletin 663; 5 cents.

*A Practical Laboratory Method of Making Thin Cross Sections of Fibers*, by J. I. Hardy. Department of Agriculture Circular 378; 5 cents.

*Handbook of Official United States Standards for Soybeans.* Bureau of Agricultural Economics; 5 cents.

*Studies of Ripening of Sugarcane in Louisiana and of Effect of Topping Upon Yields of Cane and Sugar per Acre*, by George Arceneaux. Department of Agriculture Circular 368; 5 cents.

*Effects of Particle Size on the Properties and Efficiency of Fertilizers*, by A. L. Mehring and others. Department of Agriculture Technical Bulletin 485; 5 cents.

*Cyanide Fumigation of Mushroom Houses*, by A. C. Davis and H. V. Claborn. Department of Agriculture Circular 364; 5 cents.

*Reducing Decay in Citrus Fruits with Borax*, by J. R. Winston. Department of Agriculture Technical Bulletin 488; 5 cents.

*Federal Specifications.* New or revised specifications of the Federal Specifications Board on: Paint for priming plaster surfaces (plaster primer and sealer), TT-P-56; Plaster, acoustic, SS-P-391; Products, acoustic, cast, SS-P-686; Enamel, water-resisting, red, TT-E-531a; Polish, metal, paste, P-P-556; Paints, oil, interior, egg-shell-flat-finish, ready mixed and semipaste, light-tints and white, TT-P-51; Ammonia, aqua (ammonium-hydroxide), technical, O-A-451; 5 cents each.

# A.I.Ch.E. Promulgates Tentative System For Unit Operations Nomenclature

SINCE 1932 a committee created by the American Institute of Chemical Engineers has been engaged in surveying present usage in chemical engineering literature, preparatory to recommending a standard system of symbols and nomenclature. The report prepared by the committee was accepted by the Council of the Institute on Oct. 11, 1935. In so doing it was emphasized that the system recommended is tentative and that it is to be revised and enlarged from time to time. The chairman of the committee, Prof. A. B. Newman, has stated that suggestions for improvement and additions to the system will be welcome and should be addressed to him at Cooper Union, New York.

In so far as possible the system will follow the recommendations of the American Standards Association. The list proposed encompasses only the most generally used terms, leaving the development of other terms to those requiring them for special discussions. They should, however, conform as closely as possible with the general principles set forth.

The general principles, which, with minor alterations, are those proposed by the American Standards Association (A.S.A. X10C, 1931), urge that a complete table of units and symbols used by the author be included at a convenient place in each book, chapter and paper. These principles, which are fully covered on page B150 of the Institute's quarterly Transactions (Vol. 31, No. 4, Dec. 25, 1935), deal with the use of self-consistent and engineering units and various sorts of subscripts, and with the proper use of Roman and italic characters.

### General Symbols

Acceleration due to gravity ............ $g$
Time .................... $\theta$ (theta) or $t$
($\theta$ (theta) should be used for time only when $t$ is used for ordinary temperature in the same discussion.)
Angular velocity ............ (omega) $\omega$
Velocity ........................ $u$ or $V$
Revolutions per unit time .............. $n$
Length .............................. $L$
Diameter (Reserve $d$ for differential operator) .............................. $D$
Number (e.g., of rows of tubes) ...... $N$
Radius .............................. $r$
Area .............................. $A$
(Where necessary to distinguish between interfacial area and cross-sectional area for flow, use $A$ and $S$, respectively.)
Difference in quantities . (capital delta) $\Delta$
(Generally used to represent potential difference causing heat flow, etc.)
Differential operator .................. $d$
General symbols for functions . . (phi, psi, chi) $\phi$, $\psi$, $\chi$

### General Symbols for Force, Weight, Work, and Power

Force, Total Load .................. $F$
Pressure, Absolute Pressure, Gage Pressure, Force (weight units) per unit area .............................. $p$
(Where necessary to distinguish, use $P$ for total pressure and $P$ with appropriate subscript for the vapor pressure of a pure substance; e.g., $P_A$ for vapor pressure of substance, $A$, and use $p$ for partial pressure of separate constituents with subscripts as required.)
Total quantity (of matter or energy) ... $Q$
Quantity per unit time .............. $q$
Weight rate, weight per unit time ..... $w$
Weight per unit time per unit area of cross-section, commonly called mass velocity .............................. $G$
Work per unit weight ................ $W$
Power, work per unit time ........... $P$
Efficiency .............................. $E$

### Symbols for Properties

Molecular weight .................... $M$
Concentration, Amount of particular constituent per given amount of mixture . . $c$
Density, Weight per unit volume, Mass per unit volume ............... (rho) $\rho$
Specific volume, Volume per unit weight or mass $1/\rho$ ...................... $v$
Specific heat ........................ $C$
Specific heat at constant pressure .... $C_p$
Specific heat at constant volume ...... $C_v$
Ratio of specific heats .... $\kappa$ (kappa) or $k$
Absolute viscosity, in poises or similar units ...................... (mu) $\mu$
Relative viscosity—use ............ $\mu/\mu_w$
Kinematic viscosity, $\mu/\rho$ .......... (nu) $\nu$
Surface tension .............. (gamma) $\gamma$
Coefficient of thermal expansion (volumetric) ...................... (beta) $\beta$

### Additional Symbols for Fluid Flow

Fluid head .......................... $H$
Distance above datum plane ........... $z$
Friction factor in Fanning equation .... $f$
Friction loss, energy per unit weight ... $F$
Tractive force on wetted surface per unit area ........................ (tau) $\tau$
Hydraulic radius, cross-section ÷ wetted perimeter .......................... $m$
Local velocity ........................ $u$
Thickness of fluid film ................ $B$
Coefficient (of discharge, etc.) ........ $C$
Weight rate of flow per unit width of wetted surface ...... (capital gamma) $\Gamma$
Reynolds number, $DV\rho/\mu$ (inclose in parentheses ($Re$) when necessary for clarity) .......................... $Re$

### Symbols for General Thermodynamics

Mechanical equivalent of heat .......... $J$
Ordinary temperature, F. or C. ........ $t$
Absolute temperature, F. abs. or Kelvin. $T$
Gas constant in equation $pv = RT$ .... $R$
Entropy (Capital for any weight, small letter for unit weight) .......... $S$ or $s$
Internal energy, Intrinsic energy . . $U$ or $u$
Free energy $(i - Ts)$ ................ $F$
Heat content, Total heat, Enthalpy ($i = u + (pv/J)$) ............... $H$ or $h$ or $i$
Heat of vaporization .... $h_{fg}$ or (lambda) $\lambda$

### Symbols for Heat Transmission

Terms ending "ivity" designate properties normally independent of size or shape, sometimes called "specific properties." Examples are: conductivity and resistivity.

Terms ending "ance" designate quantities depending not only on the material but also upon size and shape, sometimes called "total quantities." Examples are: conductance and transmittance.

Terms ending "ion" designate rate of heat transfer. Examples are: conduction and transmission.

Use all terms defined above. Others called for are:

Thermal conductivity (heat transferred per unit time per unit area, and per degree per unit length). $\lambda$ (lambda) or $k$

$$k = \frac{q/A}{(t_1 - t_2)/L}$$

Thermal resistivity .................. $1/k$
Thermal resistance (degrees, per unit of heat transferred per unit time) ...... $R$

$$R = \frac{t_1 - t_2}{q} = \frac{L}{kA}$$

Surface coefficient of heat transfer, Film coefficient of heat transfer, Individual coefficient of heat transfer (heat transferred per unit time per unit area, per degree) .................. $h$

$$h = \frac{q/A}{t_1 - t_2}$$

(In general $h$ is not equal to $k/L$, where $L$ is the actual thickness of the fluid film.)

Overall coefficient of heat transfer, Thermal transmittance per unit area (heat transferred per unit time per unit area, per degree overall) ...... $U$

$$U = \frac{q/A}{t_1 - t_2}$$

Stefan-Boltzmann constant .... (sigma) $\sigma$
Emissivity of surface for radiation .... $p$
Thermal diffusivity $k/\rho c$ ....... (alpha) $\alpha$

### Symbols for Absorption

Henry's law constant ................ $H$
Mole fraction in liquid phase .......... $x$
Mole fraction in gaseous phase ........ $y$
Absorption coefficient, gas film ....... $k_G$
Absorption coefficient, liquid film ..... $k_L$
Mole ratio in liquid phase ............ $X$
Mole ratio in vapor phase ............ $Y$
Surface (of packing) per unit volume... $a$
Height of tower ...................... $h$
Gross moles of vapor per unit time ... $V$
Gross moles of liquid per unit time .... $L$
Moles inert or carrier gas per unit time $V_i$
Moles inert solvent per unit time ..... $L_i$
Diffusivity, diffusion coefficient ........ $b$
Moles transferred per unit time ....... $m$

### Symbols for Distillation and Rectification

Relative volatility ............ (alpha) $\alpha$

$$\alpha = \frac{(y_A)}{(y_B)} \bigg/ \frac{(x_A)}{(x_B)}$$

Activity coefficient .................... $a$
Fugacity of pure liquid .............. $f_l$
Fugacity of pure vapor ............... $f_v$
Moles of feed per unit time ........... $F$
Moles of distillate per unit time ...... $D$
Moles of vapor per unit time .......... $V$
Moles of residue per unit time ........ $W$
Moles of liquid per unit time (reflux) . . $L$
Mole fraction in vapor phase in equilibrium with liquid phase ........... $y^*$

# *Your Plant* NOTEBOOK

## COMPACT TEMPERATURE CONVERSION CHART WITH WIDE RANGE

By Sidney Steele
*Project and Development Engineer*
*R. & H. Chemicals Division*
*E. I. duPont de Nemours & Co.*
*Niagara Falls, N. Y.*

TEMPERATURE conversions from Fahrenheit to Centigrade, and vice versa, are generally made by calculation, or through the use of tables, since by ordinary methods of plotting a chart would become inconveniently large for any but a limited range. In Fig. 1 a possible method of plotting is shown, but if such a graph were to be plotted on cross section paper having 20 divisions to the inch, allowing 2 deg. per division, its size would be 12 ft. by nearly 7 ft. if it were to cover the range shown (absolute zero to 2,920 deg. C.). However, such a chart would permit attaining an accuracy of 1 deg. and even a little better. A chart allowing much more than 40 deg. per inch could not be read to a degree.

By the expedient of doubling the graph back on itself, as shown in Fig. 2, the entire chart can be drawn on a single 7½x 10-in. sheet of cross-section paper, allowing 40 deg. per inch. It would, in fact, be possible to increase the range by another 1,400 deg. F., if desired, by utilizing the unused space on the chart. By the method of Fig. 2 the line of Fig. 1 is broken into 24 sections, corresponding to the intervals between the dots. Each section is then expanded until it can easily be read to a degree.

Since it is impossible in the space available to reproduce a chart useful to the desired accuracy, the chart given here is intended merely to serve as a guide for those who desire to construct their own. The cross-sectional divisions shown are for 10 deg., whereas in redrawing, a paper with five subdivisions would be used. Each scale is drawn so as to have a slope of 1.8. The one at the upper left is labeled *A* and the topmost horizontal scale is likewise labeled *A*. A second *A* scale, paralleling the first, commences at the bottom boundary at a point directly under where the first left the chart. Similarly, a third section of the *A* scale is drawn and all of these are used in conjunction with the horizontal *A* scale. Fahrenheit temperature designations are numbered on the *A* scales at suitable points, to the *left* of the scales. Correspondence with the designations on the horizontal *A* scale is obtained through the use of the relation: Deg. F. = (1.8 Deg. C) + 32. Then the same scales are again used, with the numbering on the *right*, to carry the temperature to twice its range on the *A* scale. This second set is labeled *B*, as is the corresponding horizontal *B* scale.

The only step in the preparation of the chart requiring particular care now follows: choosing a convenient location for the next set of lines, the *C* scales. These scales are, of course, parallel to the *A* and *B* scales and in the sample are drawn at a distance equal to 50/1.8 deg. to the right. This makes a convenient arrangement, permits the horizontal *C* scale to be drawn 50 deg. below the *A* scale and at the same time causes the designations on the horizontal scales to lie in vertical lines as shown. The remaining scales can then be put on and numbered exactly as has been shown in the preceding.

The only precaution to be observed in using the chart is the obvious one: to use only the correspondingly lettered horizontal and sloping scales. Thus a Fahrenheit temperature on sloping *D* scale will correspond to the Centigrade temperature vertically above or below it on horizontal *D* scale.

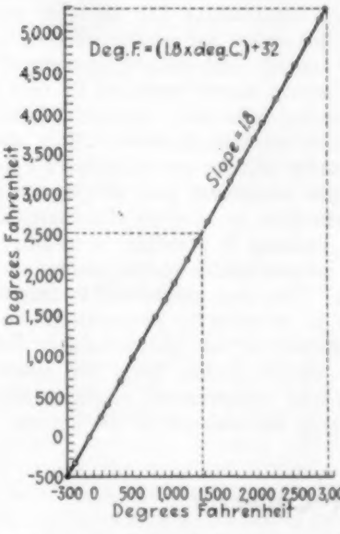
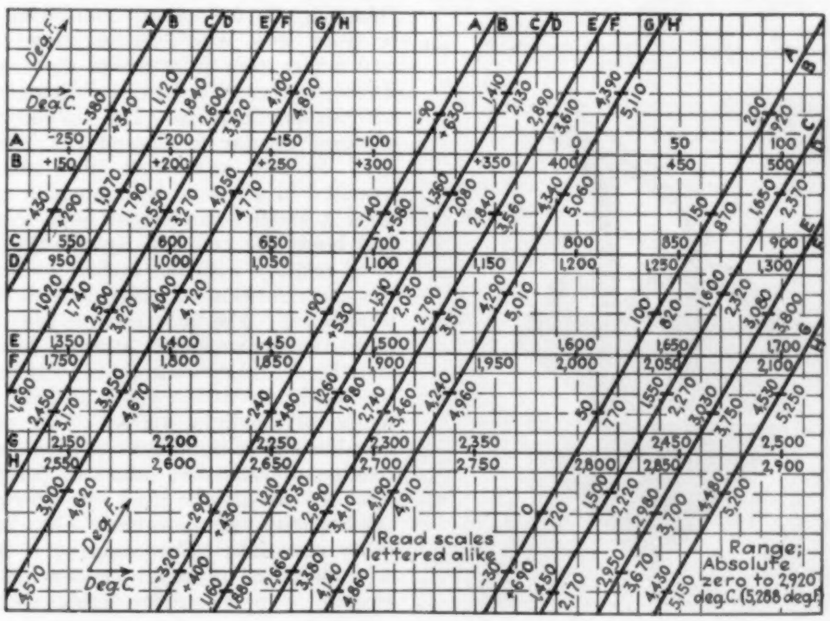



**Fig. 1 — Fahrenheit - Centigrade chart in one line, showing impracticability**

**Fig. 2—Fahrenheit-Centigrade chart broken into 24 sections for accuracy and convenient size. (Republication rights reserved by author.)**



# News of EQUIPMENT

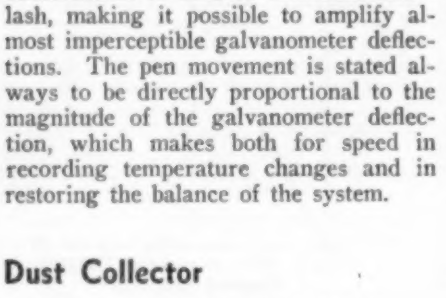
## Recording Potentiometer

Simple mechanism and a high degree of accuracy are claimed for a new recording potentiometer pyrometer recently introduced by the Bristol Co., Waterbury, Conn. The instrument employs a strip chart 12¼ in. wide and is built in styles for single record, multiple record and recording-controlling. An electric motor operated by two galvanometer-controlled contacts drives a stainless steel lead screw which simultaneously adjusts the slide wire contact and the recording pen carriage. This construction is said to eliminate backlash, making it possible to amplify almost imperceptible galvanometer deflections. The pen movement is stated always to be directly proportional to the magnitude of the galvanometer deflection, which makes both for speed in recording temperature changes and in restoring the balance of the system.

## Dust Collector

Similar in principle to a bubble tower, but with one rather than a multiplicity of bubble trays, a new dust collector recently introduced by the C. O. Bartlett & Snow Co., Cleveland, Ohio, is said to give extremely high dust collecting efficiency, combined with low maintenance and completely automatic operation. The collecting medium is water on which is floated a layer of an oil frothing agent. Dust-laden air is drawn into an equalizing chamber at the bottom of the collector, passing upward through a number of bubble caps, thence through the water and oil froth. The only moving part is the induced draft fan (or fans). It is stated that repeated tests on dust 25 per cent of which passes a 200 mesh screen (with 75 per cent ranging from 2 to 10 microns in size) have shown a collecting efficiency of 99.8 per cent by weight, or better.

Cut-away view of "froth-flotation" dust collector



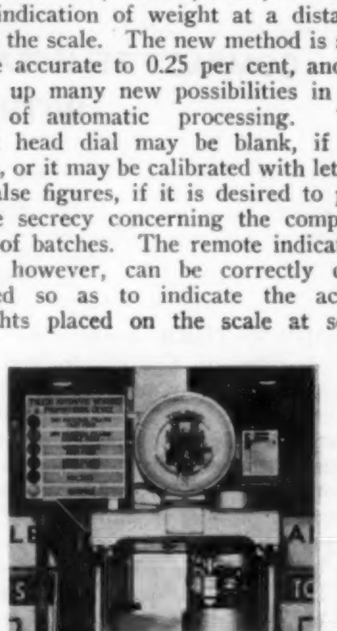
Operating cost of the collector is said to be low, about 50 cents worth of frothing agent serving to operate a 10,000 cu.ft. machine for 8 hours. Available sizes range from machines for 1,000 cu.ft. to those capable of handling 35,000 cu.ft. per minute.

## Photoelectric Instruments

A new line of photoelectric cells and instruments incorporating them has recently been announced by Pfaltz & Bauer, Inc., 300 Pearl St., New York City. The cells are of the so-called "blocking layer" type, employing a sensitive disk which generates a current under the influence of light sufficient to operate relays or instruments, without amplification. The cells have a response similar to that of the human eye. In one instrument the cell is mounted in a special holder which contains a small incandescent light source and holds the cell and light source in fixed relation with the surface or material the reflection of which it is desired to measure. The instrument is provided with a micro-ammeter, storage battery and the necessary controls for adjusting the sensitivity of the meter and the potential of the light source. The meter is calibrated in light units to give direct reading of reflection values in percentage. It can also be used for determining opacity of powders, films and other materials. The company is likewise prepared to supply a new photoelectric colorimeter for liquids which employs two of these cells. Two glass containers held in the instrument body contain the solutions. A built-in iris diaphragm permits varying the sensitivity of the colorimeter at will.

## Remote Indicating Scale

Application of Selsyn motors to the scale head and to an indicating dial placed at a distance has been employed recently, for the first time, by the Toledo Scale Co., Toledo, Ohio, in securing indication of weight at a distance from the scale. The new method is said to be accurate to 0.25 per cent, and to open up many new possibilities in the field of automatic processing. The scale head dial may be blank, if desired, or it may be calibrated with letters or false figures, if it is desired to preserve secrecy concerning the composition of batches. The remote indicating dial, however, can be correctly calibrated so as to indicate the actual weights placed on the scale at some distant point, such as the superintendent's office. At the weighing end the operation of the scale mechanism rotates one of a pair of self-synchronous motors, whereat the second of the pair, placed in the remote instrument, will follow the rotation accurately, moving the pointer to show the weight.



Demonstration unit of automatic remote-controlled weighing installation

Since the development of this mechanism, the company has been experimenting actively with remote control of weighing, with the object of permitting the complete centralized control of processing operations. The accompanying view of a demonstration weighing installation which was on display at the recent Chemical Exposition shows the

operating end of a remote-controlled weigher for proportioning a solid and a liquid. At a remote point, which might have been any reasonable distance from the scale, it was possible to start and stop the weighing, put it on continuous automatic cycle control, determine the current state of the weighing, determine the number of batches that had passed over the scale and, in general, to control the operation as effectively as if the operator were actually at the scale.

## Automatic Temperature Control

Wheelco Vacuum Products Co., Chicago, has recently developed a line of novel temperature control instruments of the pyrometric type which is being distributed by Thermo Control Devices, Inc., 1112 Milwaukee Ave., Chicago. The new instruments have no mechanical connection whatsoever between the indicating and the control system, relying upon a vacuum tube in a tuned circuit to do the work normally carried out by depressor bars or other mechanical contrivances. The pointer of the galvanometer carries a small target which swings between a tiny pair of coils attached to and capable of being moved with the temperature setting device. The vacuum tube circuit is tuned to a certain frequency which is upset when the target is between the coils, causing the tube current to rise and operate a relay and whatever control equipment is employed.

One form of instrument, known as the "Wheelco Limitrol," can be provided with an automatic switch to connect the instrument with up to 39 thermocouples. This instrument will signal and shut off the furnace or oven at any desired limiting temperature. The "Capacitrol" (illustrated) is intended for the usual type of temperature control in which the instrument operates to connect the heating means below the set temperature and to shut it off, or reduce it to a lower value, when the temperature reaches the set point.

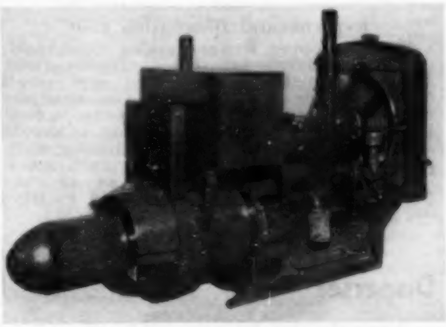
New vacuum-tube-operated temperature controller


## Packless Expansion Joint

Said to employ a new principle in expansion joint construction a packless joint, known as the U-Ring type, has been announced by the American District Steam Co., North Tonawanda, N. Y. It has been designed for the handling of steam and hot water, as well as gases or other fluids subject to change in temperature. The expansion element is a series of die-formed U-rings of stainless steel welded together without transverse seams. The joint is installed with the element compressed so that at normal line pressure it is in a neutral, unflexed condition. The expansion element is inclosed in a wrought steel body and is fully guided at three points to permit free movement of the sleeve without binding. The joint is available for pressures to 400 lb. and temperatures to 800 deg. F.

## Engine Driven Welder

What is claimed to be the lowest priced welder of its type ever offered is a new 200-amp. engine-driven "Shield Arc" electric welder that has been put

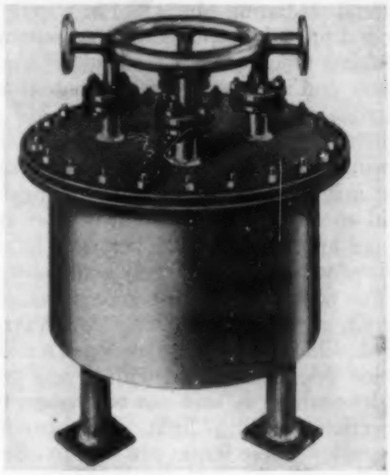


New 200-amp. engine-driven welder

on the market by Lincoln Electric Co., Cleveland, Ohio. The current range is from 60 to 250 amp. and the welder is intended for use with both bare and coated electrodes in all sizes to ¼ in. The welder is powered with a four-cylinder engine of 23 hp. at 1,400 r.p.m. The unit is compact and weighs less than 1,100 lb.

## Acid Filter

For the filtering of plating solutions, as well as other industrial acids and corrosive substances, R. P. Adams Co., Jackson Bldg., Buffalo, N. Y., has developed a lead-lined vessel housing a manufactured porous stone filtering element. The liquid enters through a single bottom connection, passing through the walls of the filtering stones and out the top openings into a collecting header. Material collected on the outer walls of the filter elements is removed periodically by back washing with city water to the sewer, an operation stated to require only a few minutes' time. Units are built in capacities ranging from 150 to 3,000



Filter for acids and plating solutions

g.p.h. The pressure loss through the filter is claimed to be well within the limitations of a fractional-horsepower motor.

## Equipment Briefs

Link-Belt Co., Philadelphia, Pa., announces the Circuline sludge collector for use in circular, centrally fed settling tanks. The machine consists of a motor-propelled, centrally pivoted structural-steel bridge, carrying the sludge collecting medium, which is driven positively at its circumference. The collecting medium, consisting of two strands of chain connected with scraper flights at suitable intervals, is of a type similar to that used for many years in rectangular tanks. The new collector is said to travel at about half the speed of other collectors used in round tanks, thus eliminating danger of agitating the lighter solids which settle at the periphery of the tank.

For handling gases and liquids, the Robinson Orifice Fitting Co., 1453 Santa Fe Ave., Los Angeles, Calif., has developed a new orifice fitting similar in appearance to a gate valve. The orifice plate is lifted out of the line of flow and into a chamber by means of a screw. The chamber may then be sealed from the line, preparatory to opening for inspection, by means of a plug valve.

The Varidrive variable speed motor, manufactured by the U. S. Electrical Mfg. Co., 1529 South Western Ave., Chicago, Ill., and previously described in a number of variations in *Chem. & Met.*, is now offered in an upright design which requires less space than the horizontal design previously available. It also offers the user the option of having the take-off shaft at either the high or low position.

A new magnetic pulley especially designed to facilitate the dissipation of heat has been announced by Dings Magnetic Separator Co., Milwaukee, Wis. The pulley has transverse and longitudinal radiating ducts. Each coil is wound upon its own bobbin and separate bobbins mounted on the pulley shaft. Outer and inner faces of the bobbins are corrugated. This structure is said to present a maximum of radiating surface. Owing to this and to care in designing the magnetic circuit, the new pulley is said to have a magnetic attraction and range approximately 25 per cent in excess of what was previously obtainable.

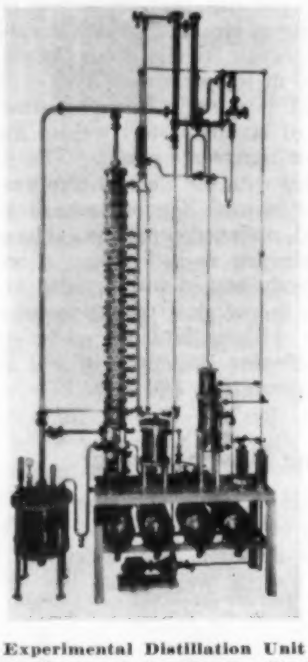
For protection against impact hazards, the Chicago Eye Shield Co., 2298 Warren Blvd., Chicago, Ill., has developed a wide-vision goggle equipped with a new type of lens which is said not to change the direction of the light rays passing through. These lenses are said to afford maximum protection with no interference to the vision of the wearer. Lenses are free from focus, ground and polished and put through a special hardening process. The new goggle is designated No. 220.

For both portable and stationary service, the Linde Air Products Co., 30 East 42d St., New York City, has developed a new small-size, medium-pressure acetylene generator. This is known as Type MP-6. It has a 50-lb. carbide capacity and a rating of 100 cu.ft. of acetylene per hour. The generator is compact, has practically no exposed piping and its mechanism is readily accessible, if necessary.

Portability is the feature of novelty in a new portable mixer announced by the Patterson Foundry & Machine Co., East Liverpool, Ohio. This unit may be equipped with various sorts of stirrers, depending on requirements. It is adapted to the stirring of paints and similar products, and to the transportation of perishable products, providing mixing facilities at both ends with only one mixer. The unit is electric powered and is provided with an extension cord for plugging in.

National Carbon Co., Cleveland, Ohio, has announced that the carbon Raschig rings of its manufacture are now available in the $\frac{1}{4}$-in. size, in addition to the seven sizes from $\frac{1}{2}$ in. to 3 in. previously available. In the new size, the rings bulk about 85,000 per cubic foot. The company has announced that the rings, as well as its other chemical carbon products, will henceforth be known under the trade name of "Kempruf."

The "runaround" conveyor, operating on the Redler system which has previously been described in *Chem. & Met.*, has recently been announced by the Stephens-Adamson Mfg. Co., Aurora, Ill. In this method of materials transportation the conveyor forms a closed loop capable of delivering bulk material at any of a number of processing points and returning any undeliverable surplus to the feed point for recirculation. The conveyor feeds itself only with enough new material to complete a normal load, regardless of the volume being recirculated.



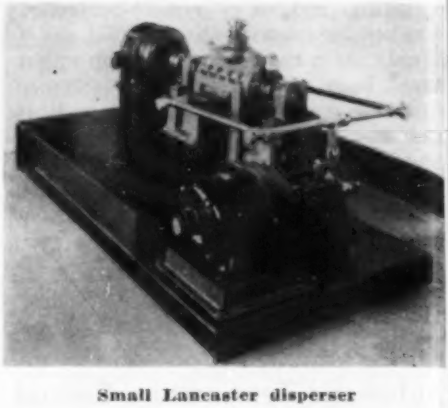
**Experimental Distillation Unit**

Vulcan Copper & Supply Co., Cincinnati, Ohio, has developed the distillation unit shown for use in pilot plant and small manufacturing work. It has also been installed in a number of engineering school laboratories. It can be used as a simple still, as a discontinuous fractionating unit, as a continuous fractionating unit, as a continuous exhausting column or as continuous compound exhausting and rectifying column.

## Disperser

A newly developed machine for producing intimate and instantaneous dispersions through the employment of extreme turbulence is the Lancaster Disperser, a recent development of Lancaster Processes, Inc., 443 Fourth Ave., New York City. This machine differs from a colloid mill in a number of particulars, notably in the fact that there are no adjustments and no close working clearances. On this count it is stated that maintenance is slight and power consumption smaller than would be expected. The machine operates from a direct connected motor and contains a pair of rotor elements mounted on the same shaft. Feed enters between the elements so as to balance the thrust. The discharge, which is taken off under pressure, is at the outer ends of the rotors and, owing to this pressure, any leakage through the stuffing boxes is outward, an important feature which prevents air from being drawn into the machine. It is stated that foam, consequently, cannot be formed.

These machines are being used both for the production of emulsions and for

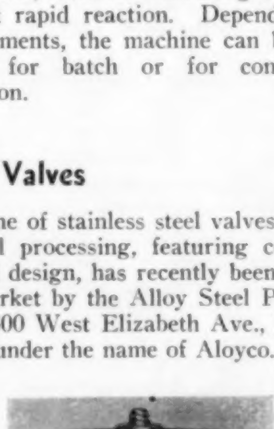


**Small Lancaster disperser**

the dispersion of solids and liquids. As an example of the first, the disperser is being used for emulsifying asphalt and water. For the second case, the production of paper coatings may be mentioned. The machine is also used for the dispersion of gases in liquids with the formation of minute bubbles and, it is claimed, efficient contacting and subsequent rapid reaction. Depending on requirements, the machine can be used either for batch or for continuous operation.

## Alloy Valves

A line of stainless steel valves for industrial processing, featuring compact, rugged design, has recently been put on the market by the Alloy Steel Products Co., 1300 West Elizabeth Ave., Linden, N. J., under the name of Aloyco. These



**New stainless steel gate valve**

valves include gates, Y, globe, angle and cross types. The latter types are available in both union and bolted bonnet designs. These valves are built for pressures of 125 and 150 lb. w.p. The metals used include 11 different stainless steel alloys capable of meeting most corrosive conditions.

# MANUFACTURERS' LATEST PUBLICATIONS

**Alloys.** Driver-Harris Co., Harrison, N. J.—8-page leaflet on heat- and corrosion-resistant alloys supplied by this company.

**Alloys.** New Jersey Zinc Co., 160 Front St., New York City—80 pages on the application of zinc alloys to die castings; 42-page book on properties of zinc die-casting alloys.

**Apparatus.** E. Leitz, Inc., 60 East 10th St., New York City—Bulletin 21—Describes this company's improved Guthrie-Leitz automatic magnetic polishing machine.

**Brushes.** Ohio Carbon Co., 12508 Berea Road, Lakewood, Ohio—Pocket-size catalog on carbon brushes for industrial and laboratory appliances.

**Chemicals.** E. I. duPont de Nemours & Co., Wilmington, Del.—6 pages on characteristics, properties, specifications and other useful information concerning chlorinated hydrocarbons.

**Chemicals.** Glyco Products Co., 949 Broadway, New York City—"Chemicals By Glyco," 36-page booklet describing products made by this company and listing numerous formulas illustrating their use.

**Chemicals.** G. Frederick Smith Chemical Co., 867 McKinley Ave., Columbus, Ohio—70 pages on mixed perchloric, sulphuric and phosphoric acids and their applications in analysis.

**Construction Materials.** Custodis Construction Co., 135 William St., New York City—22 pages on this company's acid-proof materials and construction including masonry, acidproof cement, acid- and alkali-resisting membranes, and paints.

**Coolers.** Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 1457—8 pages completely describing this company's air quenching coolers for portland cement clinker.

**Diatomite.** Dicalite Co., 20 Exchange Place, New York City—18-page booklet on diatomaceous silica and its use for fillers, filter aids, admixtures, and many other purposes.

**Electrical Equipment.** Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 1153-A—24 pages on engine-type alternators for use with reciprocating prime movers; ratings to 10,000 kva.

**Electrical Equipment.** Electric Controller & Mfg. Co., Cleveland, Ohio—Folder 1150—4 pages on new Type LTZ contactors for alternating current service; folder 1145, Type LT direct current contactors.

**Enamels.** Porcelain Enamel & Mfg. Co., Baltimore, Md.—Book illustrating this company's manufacture and testing of enamel frits; commemorates company's 25th anniversary.

**Equipment.** American District Steam Co., North Tonawanda, N. Y.—Catalog 35—130 pages with prices and engineering data on this company's line of expansion joints, meters, steam traps, pipe fittings and other steam distribution equipment.

**Equipment.** General Electric Co., Schenectady, N. Y.—Publications as follows: GEA-2209, bearing-temperature relays; GEA-2227, 600 volt d.c. contactors; GEA-1145C, steam turbines for mechanical drive.

**Equipment.** National Lead Co., 111 Broadway, New York City—Folder describing this company's homogeneous lead linings and their application to pumps, pipe and fittings, valves and equipment.

**Equipment.** F. J. Stokes Machine Co., Olney P.O., Philadelphia, Pa.—Catalog 35—48 pages illustrating and describing the complete line of process equipment made by this company, including dryers, extraction and solvent recovery equipment, condensers, vacuum pumps, autoclaves, tablet machines and other equipment.

**Equipment.** Worthington Pump & Machinery Corp., Harrison, N. J.—Publications as follows: L-611-B4A, Long-stroke, single-stage compressors; L-611-B5A, short-stroke, single-stage compressors; W-102-B1, horizontal, duplex piston pumps; W-312-B1A, single-stage centrifugal pumps; W-321-B7, Monobloc centrifugal pumps; W-412-B5, horizontal duplex power pumps; WP-1088, describes this companys FHA time payment purchase plan.

**Floors.** Flexrock Co., 800 North Delaware Ave., Philadelphia, Pa.—4-page leaflet describing this companys resurfacing material for repairing concrete floors.

**Furnaces.** Detroit Electric Furnace Co., 825 West Elizabeth St., Detroit, Mich.—"Modern Melting," 39-page cooperative catalog on this company's rocking electric furnace equipment, with pages devoted to accessory products made by other manufacturers.

**Grinding.** Raymond Bros. Impact Pulverizer Co., 1315 North Branch St., Chicago, Ill.—8-page catalog completely describing this company's new bowl mill.

**Grinding.** Williams Patent Crusher & Pulverizer Co., 2701 North Broadway, St. Louis, Mo.—Form 528—8 pages describing this company's roller mills, air separators and dryer mills.

**Heaters.** Electric Air Heater Co., Mishawaka, Ind.—Data Book 236—24 pages illustrating and describing space heating with this company's fan-type unit heaters.

**Heaters.** Griscom-Russell Co., 285 Madison Ave., New York City—Form 496—4 pages on storage tank oil heaters made by this company.

**Heaters.** Ross Heater & Mfg. Co., 1407 West Ave., Buffalo, N. Y.—Form 1046—Describes fuel oil heaters and tank suction heaters made by this company.

**Heating Equipment.** Harold E. Trent Co., 618 North 54th St., Philadelphia, Pa.—Leaflet TC 30—6 pages on strip and other type electric heaters and immersion units; TE-20, 4 pages on pot and trough type electric furnaces.

**Instruments.** Brown Instrument Co., Philadelphia, Pa.—Folder describing means used for adjusting this company's new line of air-operated controllers to exact demands of individual processes.

**Instruments.** Esterline Angus Co., Indianapolis, Ind.—Bulletin 725—4 pages describing a new graphic kva. meter made by this company.

**Instruments.** Foxboro Co., Foxboro, Mass.—Bulletin 202—22 pages on this company's potentiometer and resistance-thermometer controllers.

**Instruments.** Julien P. Friez & Sons, Inc., Baltimore, Md.—Bulletin H—4 pages describing this company's combination relative humidity and dry-bulb recorders.

**Instruments.** Leeds & Northrup Co., 4902 Stenton Ave., Philadelphia, Pa.—Broadside E 250—Briefly describes this company's entire line of electrical instruments for research, teaching and testing.

**Lighting.** Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa.—32 pages on lighting, the science of seeing, and the use of proper paint finishes in securing adequate lighting.

**Materials Handling.** Dracco Corp., Harvard Ave. and East 116th St., Cleveland, Ohio—Bulletin 525—12 pages, thoroughly illustrated, describing this company's pneumatic conveyor equipment, showing typical installations.

**Materials Handling.** Jeffrey Mfg. Co., Columbus, Ohio—Catalog 417—400 pages on chains, sprockets, transmission machinery, conveyor and elevator parts and other materials handling equipment parts, listing specifications and prices. Also Catalog 610, 64 pages on this company's Jeffrey-Traylor vibrating equipment for materials handling, screening, packing and other operations.

**Materials Handling.** Lewis-Shepard Co., 238 Walnut St., Watertown Station, Boston, Mass.—Circular 199—Illustrates and briefly describes a wide variety of portable elevator equipment. Also leaflets describing floor trucks and barrel and drum handling equipment.

**Materials Handling.** Palmer-Bee Co., Detroit, Mich.—Section 106, General Catalog 100—288 pages, with engineering data, covering elevating and conveying machinery for bulk handling.

**Materials Handling.** Robins Conveying Belt Co., 15 Park Row, New York City—Bulletin 96—4 pages on this company's Mead-Morrison pivoted bucket conveyors.

**Materials Handling.** Sullivan Machinery Co., 1600-A Bell Building, Chicago, Ill.—Bulletin 76-X—12 pages on single- and double-drum electric and air hoists.

**Metals.** Lukens Steel Co., Coatesville, Pa.—Form 18-AV—24 pages on applications of this company's nickel-clad steel.

**Microscopes.** Bausch & Lomb Optical Co., Rochester, N. Y.—Leaflet describing a stereoscopic camera and stereoscope for preserving three dimensional records of objects at magnifications of 1 to 24; 8 pages on this company's type H laboratory microscope.

**Mixers.** Patterson Foundry & Machine Co., East Liverpool, Ohio—Catalog 355—52 pages describing motors and drive equipment for agitators, various agitator types and complete mixing equipment in a wide variety of styles.

**Motors.** Louis Allis Co., Milwaukee, Wis.—24-page catalog descriptive of motors made by this company for use in chemical industries.

**Plastics.** General Plastics, Inc., North Tonawanda, N. Y.—Vol. 1, No. 1, "Durez Plastics News," a new monthly leaflet devoted to uses of plastics.

**Power Transmission.** Foote Bros. Gear & Machine Co., 5301 South Western Blvd., Chicago, Ill.—Catalog 350—128 pages on history and development of worm gearing and worm-gear reducers with data, curves and tables.

**Power Transmission.** Johns-Manville, 22 East 40th St., New York City—Bulletin FM-4A—8 pages on industrial friction materials; also reprints of three articles of a series on "Research at Johns-Manville," covering diatomite, refractories and packings.

**Power Transmission.** Link-Belt Co., 910 South Michigan Ave., Chicago, Ill.—Catalog 1519—32 pages on single,- double- and triple-reduction herringbone-gear speed reducers.

**Power Transmission.** Manhattan Rubber Mfg. Division, Raybestos-Manhattan, Inc., Passaic, N. J.—New catalog on this company's industrial friction materials; also second edition of this company's general catalog on belting, hose, packing, molded goods, friction material, etc.

**Power Transmission.** Morse Chain Co., Ithaca, N. Y.—Ingenious slide and window type chart for simplifying selection of chain drives, giving for desired horsepower and r.p.m. of driving and driven sprockets, size of both sprockets, ratio, size and length of chain and center distance.

**Pumps.** Allen-Sherman-Hoff Co., Lewis Tower, Philadelphia, Pa.—Catalog 735—24 pages completely describing this company's rubber-lined sand pumps.

**Pumps.** Allis-Chalmers Mfg. Co., Milwaukee, Wis.—4-page leaflets as follows: 2206, large low-head, single-stage centrifugal pumps; 2207, large high-head, single-stage pumps; 2208, small single-stage pumps; 2210, multi-stage pumps.

**Pumps.** Ingersoll-Rand Co., 11 Broadway, New York City—Bulletin 9042—24 pages on this company's method of pumping by means of air lifts, describing economics, calculations and typical installations.

**Respirators.** Mine Safety Appliances Co., Pittsburgh, Pa.—Bulletin CR-3—Describes this company's Comfo respirators for use in lead dust, nuisance dusts and chromic acid mist. Also Bulletin DS-1, 4 pages on this company's portable carbon monoxide indicator.

**Screens.** J. H. Day Co., Cincinnati, Ohio—Bulletin 363—8 pages on this company's gyrating screens, describing also dry mixing equipment.

**Screens.** W. S. Tyler Co., Cleveland, Ohio—Bulletin 526—24 pages illustrating and describing this company's type 400 Hummer electric screens.

**Separators.** Separations Engineering Corp., 110 East 42d St., New York City—7-page pamphlet describing the Frantz FerroFilter, a magnetic separator for liquids and slips.

**Steam Generation.** Combustion Engineering Co., 200 Madison Ave., New York City—Publications as follows: Bulletin MR-3, 8 pages on multiple retort stokers; C-5, 16 pages on chain-grate stokers; S-2, 16 pages on this company's sectional-header boilers.

**Stoneware.** U. S. Stoneware Co., Akron, Ohio—Bulletin 901—4 pages describing advantages and application of this company's Flexlock rubber joints for stoneware pipelines; also catalog pages covering chemical stoneware centrifugal and plunger pumps, exhausters and exhaust fans, and alloy pumps.

**Valves.** William Powell Co., Cincinnati, Ohio—23-page catalog on corrosion-resistant valves and on a wide range of alloys, giving physical properties and recommendations regarding use.

**Water Treatment.** Permutit Co., 330 West 42d St., New York City—Leaflet announcing and describing this company's new Pacometer, a hydrometric method for determining salines in boiler water.

**Welding.** Lincoln Electric Co., Cleveland, Ohio—42-page book on the use of this company's "Electronic Tornado" equipment in a wide range of automatic arc-welding applications.

# Chemical Engineering NEWS

## Gas Manufacturers Will Meet at Waldorf

THE annual convention of the Compressed Gas Manufacturers' Association, Inc., will be held at the Waldorf-Astoria Hotel, Jan. 20-21. Luncheons will be held on each of those days and a banquet will be given on the evening of Jan. 21.

The theme of the principal technical session will be the testing of compressed gas cylinders. These cylinders are subject to Federal regulation which requires that they be retested at stated intervals. The subject of cylinder testing, therefore, is one of extreme importance. The principal paper covering this subject will be presented by H. B. Liggett, general manager of the Harrisburg Steel Corp., Harrisburg, Pa.

Others who will take a part in this presentation include Col. Guy E. Carleton of the Bureau of Explosives; Col. John C. Minor of Wm. Wharton, Jr. & Co. A representative of the American Welding Co. will discuss the testing of the large containers which constitute a part of the multiple unit tank car used in the transportation of some compressed gases.

During another session Walter L. Savell of Mathieson Alkali Works, Inc., will present a paper entitled "In Defense of Gases." Dr. M. Hillel Feldman will address the Medical Gas Division of the Association. The topic of his discussion will be "The Attitude of the Lay Public toward General Anaesthetics, With Particular Reference to Dental Operations." Dr. Feldman is Chief of the Dental Department of Lincoln Hospital, New York City. He is also instructor of General Anaesthesia for the Allied Council of New York.

The interests of the manufacturers of compressed gases finds a mutual problem in research looking toward the improvement of containers. Some of the research developed during the past year was devoted to the physical properties of steels used in the construction of these containers. Some fundamental engineering studies were made which will be discussed in a paper to be presented jointly by F. Eder of Robert W. Hunt Co. and V. J. Hill of Walter Kidde & Co.

"The Applications of Apparatus Used in the Continuous Analysis of Gases" will be the topic of another paper which will be presented by W. O. Hebler, of Charles Engelhard, Inc.

## Discoverer of Glycerine Honored on Anniversary

A TRIBUTE of respect was paid last month to one of the great pioneers in chemistry, the Swedish scientist Dr. Karl Wilhelm Scheele. Although celebrated especially as the discoverer of glycerine, Dr. Scheele has to his credit the isolation and analysis of a long list of other substances unknown before his time.

On Dec. 19, the one hundred and ninety-third anniversary of Scheele's birth, the American - Scandinavian Foundation cabled to Crown Prince Gustaf Adolf of Sweden expressing appreciation for his nation's service, through Dr. Scheele, to human progress. The cable was signed by the president of the Foundation, Henry Goddard Leach.

Dr. Scheele first extracted glycerine in 1779. The one hundred and fiftieth anniversary of this discovery was observed here in 1929. The organized glycerine producers at that time sent a memorial resolution to the Royal Academy of Sciences in Sweden which evoked a gracious response from the Crown Prince.

## Concern Formed to Market Breerwood Process

SEPARATION PROCESS CO., with office, research and testing laboratories at Catasauqua, Pa., has recently been organized to market the Breerwood process for preparing suitable cement raw material mixtures from inferior raw materials. The process, which was described in detail in *Chem. & Met.* (Feb., 1935, pp. 68-72), utilizes metallurgical concentration methods, including classification and froth flotation, in removing undesired components from the mill's raw material, making it independent of outside raw material supplies. The process has been employed for all cement made since Mar. 15, 1934, at the plant of the Valley Forge Cement Co., where it was developed. Three cement companies are understood recently to have closed contracts for complete separations plants.

The company has acquired the Breerwood patents and applications. Its officers include C. H. Breerwood, president; A. E. Douglass, vice-president; R. S. Weaver, treasurer; and S. E. Danner, secretary.

## Ford Will Install New Glass Furnace

REPORTS from Detroit in the early part of this month stated that the Ford Motor Co. had called for tenders on a glass melting furnace which will be set up in the Rouge plant at Dearborn. The furnace will cost about $500,000 and will increase the capacity of the plant from 75,000 to 200,000 sq. ft. of rough plate glass a day.

For several months installation of a glass grinding and polishing line has been going on. The existing furnace is similar to one formerly in use at the Highland Park plant, where plate glass was made for the first time by the continuous process.

The production capacity of the grinding line is more than double that of the existing furnace. The second furnace, which is expected to be in operation within five months, will co-ordinate production of rough plate glass to finished safety glass.

## Swann & Co. Building New Chemical Plant

HEADED by Theodore Swann, who formerly was president of the Swann Corp., now merged with Monsanto Chemical Co., a new company, Swann & Co., has been formed at Birmingham, Ala., and work is under way on construction of a laboratory and office building at 32d St. and Second Ave., South. In addition three units nearby have been leased and will be used for manufacturing purposes.

Officers of the new company are: Theodore Swann, president; Paul Logue, vice president in charge of operations; F. E. Nabers, Jr., vice president in charge of sales; Dr. R. R. Bottoms, director of research; Mrs. Catherine D. Swann, treasurer; Miss Alma Lide, assistant secretary and treasurer, and Miss Elsa P. Thern, New York City, assistant secretary and treasurer.

McGraw-Hill President Malcolm Muir, Retiring Chairman James H. McGraw and his successor, James H. McGraw, Jr.
Candid camera catches Chem. & Met. publishers in jovial mood at University Club party celebrating Malcolm Muir's thirty years in publishing business.

## James H. McGraw Resigns As Chairman of Board

AT a meeting of the board of directors of the McGraw-Hill Publishing Company, Inc., held on December 27, 1935, James H. McGraw, the founder of the company and its head for more than fifty years, resigned as chairman of the board and was elected honorary chairman. He will remain as a member of the board.

James H. McGraw, Jr., who has been connected with the company for the past twenty years, was elected chairman of the board. He has served as treasurer and was executive vice-president and vice-chairman of the board at the time of his election.

Malcolm Muir, president of the company since 1928, continues in that capacity.

## Plans Announced for British Tour of Chemical Engineers

DIRECTLY following the International Chemical Engineering Congress to be held in London June 22-27, the members and delegates from the American Institute of Chemical Engineers plan to join with the British Institution of Chemical Engineers in an eight-day tour of Southern and Central England and North Wales, terminating in Liverpool, July 5, in time for the annual meeting of the Society of Chemical Industry July 6-11. Preliminary plans announced by Chairman A. E. Marshall at Columbus (see *Chem. & Met.*, December, pp. 666) may now be supplemented by the detailed itinerary which has just been forwarded to the American Committee by Dr. H. W. Cremer, honorary secretary of the Institution of Chemical Engineers.

Subject to minor changes in detail, the program will be substantially as follows: Sunday, June 28, a day's visit to Canterbury and neighboring districts.

Monday, June 29—Morning: semi-annual meeting of the American Institute of Chemical Engineers; afternoon, leave for Winchester arriving at Salisbury in the evening. Evening: dancing.

Tuesday, June 30—Sunrise at Stonehenge, returning to Salisbury for breakfast. Sightseeing in Salisbury district, ending up at Bath in the evening.

Wednesday, July 1—Visit to Glastonbury and Wells, followed by plant visit, arriving for the evening at Bristol.

Thursday, July 2—Trip through Wye Valley, Tintern, Monmouth, Gloucester and Tewkesbury, arriving at Stratford-on-Avon for special performance at the Shakespeare Memorial Theatre.

Friday, July 3—Journey through Phoenix, North Wales to Llandudno.

Saturday, July 4—Llandudno to Chester in the morning, visits in the afternoon to historical residences, followed by gala dinner in the evening.

Sunday, July 5—Chester to Liverpool.

Final plans for the annual meeting of the Society of Chemical Industry which begins July 6 have not been developed, but will include technical papers, social functions and visits to industrial plants and historical spots in the vicinity of Liverpool.

Sailing arrangements have been made for the American party to depart on the S. S. "Samaria" of the Cunard Line, leaving New York June 12 and arriving in London (via Liverpool) June 21, the day before the organization meeting of the International Chemical Engineering Congress. Arrangements for return from England will be made on a sufficiently flexible basis to permit sailing from Liverpool or Southampton July 4, 8, 10 or 11, and in the event that members of the party desire to extend their stay or include continental travel, the necessary arrangements can be made in advance through the New York Travel Service, Inc., 18 East 53d St., New York City, or on arrival in England through the Travel Bureau associated with the British Committee.

Despite the fact that Transatlantic travel rates have been increased since December, American arrangements were made previous to the increase so that the round-trip fares based on the S. S. "Samaria" from New York and an equivalent cabin steamer and equivalent accommodations from England to New York will range, per person, from $302 to $352 less 7½ per cent. Further information regarding plans for the tour may be obtained from the New York Travel Service or from the office of the executive secretary of the American Institute of Chemical Engineers, F. J. LeMaistre, Bellevue Court Building, Philadelphia, Pa.

## CALENDAR

NATIONAL ASSOCIATION OF USED MACHINERY AND EQUIPMENT DEALERS, annual meeting, Pittsburgh, Jan. 18.

FOURTH INTERNATIONAL HEATING AND VENTILATING EXPOSITION, Chicago, Jan. 27-31.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY, annual meeting, New York, Feb. 17-20.

CANADIAN CERAMIC SOCIETY, annual meeting, Toronto, Feb. 17-18.

AMERICAN CERAMIC SOCIETY, annual meeting, Columbus, Ohio, Mar. 29-Apr. 4.

AMERICAN CHEMICAL SOCIETY, Kansas City, Apr. 13-17.

ELECTROCHEMICAL SOCIETY, annual meeting, Cincinnati, Apr. 23-25.

AMERICAN PETROLEUM INSTITUTE, mid-year meeting, Tulsa, Okla., May 13-15.

INTERNATIONAL CHEMICAL ENGINEERING CONGRESS, London, England, June 22-27.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, June 29-July 3.

## Technical Papers Prepared For TAPPI Meeting

THE annual meeting of the Technical Association of the Pulp and Paper Industry will be held at the Waldorf-Astoria Hotel, New York, February 17-20.

The program lists a wide range of topics on which papers will be presented. Heat and power engineering will be discussed by H. W. Rogers, F. W. Adams, V. F. Waters, A. E. Montgomery, M. J. Reed, E. W. Butzler, and C. J. Koch. Materials of construction will be discussed by F. L. LaQue, J. T. Kemp, and J. W. Hemphill. R. E. Reed and S. J. Dickhaut will present papers on paper coatings. Otto Kress and L. A. Moss will speak on sulphite pulping, F. E. Brauns on bleaching, and L. T. Stevenson on management.

Stuff preparation will form the subject of papers by G. W. Dodge, Edwin Cowles, and D. M. Sutherland, Jr. On mechanical pulpings speakers will include J. C. Pew, R. G. Knechtze, M. Y. Pillow, and E. R. Schafer. W. T. Marble will read a paper on laminating of boards and pigments will be handled by F. A. Steele, J. H. Haslam, and W. R. Willets.

## NEWS FROM WASHINGTON

By PAUL WOOTON

*Washington Correspondent of Chem. & Met.*

WASHINGTON in early January suffers from three simultaneous sources of commotion—The President, the Congress, and the Supreme Court. Within three successive days it had to absorb, and try to digest, an annual message from the President of unprecedented character, the convening of Congress, a budget plan, and an epoch-making ruling by the Supreme Court with reference to AAA.

Deliberate examination of these events is difficult, but not impossible. And engineers, as well as business executives, are undertaking the task valiantly. Upon the accuracy of the interpretations reached will depend the early course of many divisions of business. Hence review at this point is undertaken, and so far as is possible without any intention of partisan political significance.

#### Presidential Message

Neutrality and regulation of international trade were made an outstanding issue of the present year, and also a prospective basis of partisan controversy because associated in the President's annual message to Congress with other matter obviously political. Hitherto such questions have been regarded as nonpartisan. It is possible, though far from sure, that they may again be detached from politics during their legislative consideration.

Under the "good neighbor" policy the United States is unquestionably going to continue restriction on the movement of arms, ammunition, and implements of war to belligerents. The President's present authority will not be allowed to lapse at the end of February; it is much more likely that even the limited discretion which the Executive now has will be eliminated, and that *all* such goods will fall under a ban with respect to *all* belligerents.

Furthermore, Congress will undoubtedly support the President's recommendation that steps be taken to limit trade in other goods, not directly munitions, to quantities comparable with peace-time need. Here again the President is likely to receive a mandate from Congress, not discretionary power. One of the most probable causes for controversy between the President and the Congress this year is over the extent to which discretion will be so given.

If the rest of the President's message to Congress, delivered January 3, had been on the same plane as his neutrality discussion, there would not have been the ground for bitter attack which has followed, with the charge of "demagoguery" and "stump-speech" making. But whatever one thinks of the rest of the message politically, it must be accepted as something of a guide to the prospective policy of the New Deal administration in its requests to Congress during the present session. As such, it points to a continued pressure for as much authority in the Government to control business as may be possible within Supreme Court limitations.

#### AAA Debacle

The sweeping condemnation of regulation of agriculture attempted under AAA, that was accorded in the January 6 Supreme Court decision, stunned Washington. The Court went so far beyond a comprehensive decision as to eliminate all question or doubt as to whether a modified agricultural-relief program could be fathered in the present Congress. Attempts will still be made to benefit agriculture; but no one at first study anticipates even as long a continuance of AAA following this Hoosac decision as of NRA in the post-Schechter period.

#### The Budget

Few surprises are found in the budget plan submitted to Congress January 6. But it is evident that the President will not be able to stick close to his program there outlined, both because of the certain passage of bonus-settlement legislation, creating new money burdens, and because of the Supreme Court decision, precluding any "permanence" for AAA and some other agencies contemplated in the fiscal program.

The President's message stated that no new taxes would be needed this year *under then existing law*. The Supreme Court decision which makes disbursement for agriculture virtually impossible, eliminates that type of burden, but takes with it the source of corresponding income. New taxes are to be expected, therefore, primarily as a response to bonus-paying need.

#### Power Alcohol

The hardy perennial idea of alcohol from agricultural materials is again blooming in Washington. The possibility of using alcohol manufacture as a subsidized outlet for agricultural surpluses now under Governmental control, is not new. This idea has more important backing this year and may, therefore, require more serious attention on the part of interested industry.

Under present circumstances it is evident that direct money subsidy will be required for corn, potatoes, beets, Jerusalem artichokes, or any other farm crop if it is to be processed into alcohol in competition with molasses now at contract prices of about 5 cents per gallon. It is being argued by some officials that such money subsidy to the alcohol maker is less burdensome on the Treasury than other methods of farm-surplus relief. This argument appears to be based on the theory that all the alcohol which could so be made would be readily marketable at 25 cents per gallon. The subsidy under such circumstances would be about 15 cents per gallon for alcohol made from 40-cent or "low-grade" corn. No official decisions as to policies in these matters have been announced up to early January, but in the present Washington situation anything can happen, some queer things probably will, even with the Supreme Court AAA decision in force.

Incidentally, none of the much talked of new formulas for denatured alcohol are any closer to approval than a year ago. Alcohol regulations now relate mainly to merchandising phases of beverage alcohol, containers, labeling, and grade indication. None of these questions have importance for the industrial user of denatured alcohol; but they are of vital importance to the beverage maker and the container interests, both bottle and can makers.

#### Weed Killers

Chemicals for weed killing are under investigation by the Bureau of Chemistry and Soils and the Bureau of Plant Industry of the Department of Agriculture. The chemical work relates to possible improvement in methods of manufacture, particularly of sodium chlorate. The hope is that cheaper material can be produced in order that wider usage may be developed, especially for those range weeds like the bind vine of Texas, and the thistles which materially reduce agricultural effectiveness in large areas of the West.

The Bureau of Plant Industry is engaged on experimental usage of sodium chlorate and will consider other chemicals in field trials on large areas. The objective of this part of the investigation is a determination of the methods of application, necessary concentration, and frequency of repetition required for effective killing under different climatic, weather, and soil conditions. Chemicals used in this field work are being purchased commercially. There is some

talk about making these chemicals on a large scale at a Government plant to be placed at Muscle Shoals if the chemical investigation develops sufficiently attractive new manufacturing procedure. That development will, however, certainly not come for at least another year.

#### Bleaching Clays

Clay deposits which promise important industrial development as bleaching clay for use in refining petroleum are described in a preliminary report of the United States Geological Survey recently presented by G. R. Mansfield. In four Florida counties—Jackson, Jefferson, Leon, and Washington—there have been deposits identified which seem to promise successful development.

Referring to this material Dr. Mansfield emphasizes the commercial possibilities in the following language: "The significance of the discovery is that the better grades of activable clays, when properly treated, are from two to five times as efficient in bleaching action as fullers' earth of commercial grade. Activable clays contain altered volcanic ash and are commonly called 'bentonits' or 'bentonitic clays.' The naturally active clays (fullers' earths) are ordinarily not improved in bleaching power by acid treatment—in fact, many of them lose part of their activity when so treated."

Another report by the same author describes certain Alabama ceramic claims which indicate possibilities of commercialization of kaolin as a plastic refractory clay from several counties of Alabama. These reports, and a number of others in preparation, indicate the new emphasis being placed by the Survey on the non-metallic minerals of the South. A number of such industrial developments is anticipated now that funds for commercialization of projects seem more readily available.

#### Fertilizer Industry Code

The fertilizer industry's Federal Trade Commission agreement is regarded by trade associations and attorneys as the finest pact of its kind so far drafted.

A novel and expected to be effective feature of the agreement is the method set up for securing compliance with group II FTC rules by providing in the by-laws of the agency or agencies which will administer it for payment of liquidated damages in lieu of assessment of penalties upon violaters. This attempt to get away from code administration by coercive methods becomes questionable, however, when it is applied to group I rules as proposed. The latter rules merely constitute a restatement of unfair methods of competition that are illegal per se and the penalty for violation of them comes wholly within the province of the Federal Trade Commission and the courts. Therefore, enforcement of group I rules would not only rest on firmer grounds if the liquidated damages were left out, but there would be no cause for expression of jealousy with which the courts and quasi-judicial agencies of the government regard their prerogatives.

The open price filing provisions of the code probably explain why the commission has not acted on the code to date, but they are expected to gain the commission's approval because their purpose is to give the general public and the trade honest information with respect to prices.

#### Netherlands Tariff

Late in December, the terms of the trade agreement between the United States and the Kingdom of the Netherlands were made public. And again chemical industry found evidence of the tariff-lowering intention of the President and Secretary of State Hull. Reductions in the duty that are of interest to the chemicals industries were made on the following commodities: Amyl alcohol, fusel oil, laundry sour, ammonium silicofluoride, haarlem oil, caffeine, theobromine, flavoring extracts containing more than 50 per cent of alcohol, amyl acetate, edible gelatin valued under 40c. per lb., refined glycerin (⅝c. per lb. differential over 1c. rate on crude glycerin guaranteed), cajeput oil, lithopone containing less than 30 per cent of zinc sulphide, potato starch, and dextrine made from potato starch or potato flour.

Other commodities bound on the free list or otherwise influenced by decisions favorable to the Netherlands were: Ammonium sulphate, copal, crude gutta percha and gutta siak, distilled or essential caraway oil not containing alcohol, distilled or essential citronella oil not containing alcohol, palm oil (processing tax of 3c. per lb. bound against increase), quinine sulphate and all alkaloids and salts of alkaloids derived from cinchona bark, and crude sago and sago flour.

In announcing the decisions on these and other commodities, the State Department indicated in part its philosophy of action. This philosophy deserves thoughtful study as it will probably be applied to other commodities in subsequent negotiations with other nations. Some of the more interesting points are as follows:

"Imports of refined glycerin are equal to about 2 per cent of domestic production and the Netherlands is usually the principal source of imports. The reduction in duty from 2 cents per pound to 1⅝ cents per pound carries with it the guarantee that the ⅝ cent differential between the duty on crude glycerin (1 cent per pound) and the duty on refined glycerin will be maintained should the duty on crude glycerin be reduced in subsequent negotiations with any other country. Refiners of glycerin are large-scale producers and are few in number compared with the producers of crude glycerin, most of whom are small-scale producers who do not refine their output but sell it to the larger refineries."

"Amyl acetate is produced from amyl alcohol and acetic acid. . . . Imports of this product are negligible. The rate of duty under the Tariff Act of 1930 (7 cents per pound) is in excess of that necessary to compensate for duties on the raw materials from which it is made. The duty is reduced to 4 cents per pound, which is equivalent to about 14 per cent ad valorem."

"The rate of duty on amyl alcohol and fusel oil was raised in 1922 from ¼ cent to 6 cents per pound, an increase of 2,300 per cent. The present reduction, to 4 cents per pound, probably will not result in any great influx of imports because of the increased use of substitutes, especially domestic butyl alcohol and synthetic amyl alcohol."

"Laundry sour, which is a mixture of sodium silicofluoride and oxalic acid, is used by laundries as an acid rinse to neutralize alkalis. It is an unimportant product which is imported in very small amounts, practically exclusively from the Netherlands. The duty is reduced from 25 per cent to 15 per cent ad valorem."

"The binding of ammonium sulphate on the free list will be of benefit to American farmers. In 1933 ammonium sulphate supplied almost 70 per cent of the nitrogen content of commercial fertilizers consumed in agriculture. Quinine sulphate is an important medicinal made from the bark of cinchona trees, which are cultivated almost exclusively in the Netherlands Indies. Caraway seeds, caraway oil, and undressed moleskins are imported only in small quantities and are not competitive with domestic industry."

## S. W. Jacobs President of Chlorine Institute

ANNUAL meeting of the Chlorine Institute was held at the Chemists Club, New York, on Dec. 20. Routine business matters were disposed of and the following directors were elected: J. F. C. Hagens, Great Western Electro-Chemical Co.; H. M. Hooker, Hooker Electrochemical Co.; S. W. Jacobs, Niagara Alkali Co.; and E. C. Speiden, Isco Chemical Co. The directors then elected officers for the ensuing year as follows: S. W. Jacobs, president; E. C. Speiden, vice-president; Robert T. Baldwin, secretary-treasurer.

# GERMANY STRESSES USE OF DOMESTIC RAW MATERIALS FOR FUEL MANUFACTURE

**From our Berlin Correspondent**

USE of domestic raw materials in manufacture of fuels was stressed in addresses made at the recent meeting of the German Mineral Oil Society. A report on the benzine synthesis of Franz Fischer and his late colleague, Hans Tropsch, was presented. This synthesis is now of interest because three rather large plants are either being constructed or are already operating in Germany. A fundamental advantage of this system in contrast to the "classic" benzine synthesis of I.G. is that it permits the use of light sheet iron apparatus. For this reason, plants producing 25,000 tons annually can operate with profit and can be constructed quickly. Another advantage of this process is that up to half of the heat value of all the gases entering into the synthesis is obtained in the form of heat of reaction. Therefore the apparatus is so constructed that large quantities of heat can be transferred to oil or water and removed from the reaction. Thus saturate steam (200-240 deg. C.) is obtained as a by-product of the reaction and is available for operating purposes.

According to an address by A. Thau, the distillation of brown coal, which supplies, upon hydrogenation, the tar which is so valuable as a starting material for the benzine synthesis, is made more profitable by coupling the distillation ovens with power plants or by the production of the so-called roll press briquettes. The latter retain their lump form even after distillation and can be shipped. This overcomes sales difficulties experienced with distillation coke. At the present time 38 coke oven units are being built in Germany with a total output of about 10,000 tons of briquettes —each unit having a daily output of 250-300 tons.

The procedure is as follows: mining, wet dressing, drying, briquetting, distillation, tar hydrogenation. According to the Büttner process the briquette is dried without steam in a hot gas stream. The briquettes to be distilled are produced at a new plant with the roll type presses developed by Lurgi-Krupp-Gunson. The tar is precipitated electrically and the light oil is obtained from the gases in Feld centrifugal washers. The brown coal is also prepared so that it can be used in the Fischer synthesis. A very cheap water gas from brown coal is being made with the Bubiag-Didier process in a large pilot plant at Kassel.

For this purpose ovens are used with vertical, externally heated chambers and with provision for continuous feeding and removal of fuel; superheated steam enters at the bottom of the charge, which consists of ordinary brown coal briquettes. Enough steam is used so that only the amount of coke which is necessary to heat the chambers is left over. This coke is gasified in special generators and the chambers are heated with the gas thus obtained. According to this principle the largest distillation plant in the world is now being built at Böhlen, near Leipzig. The proposed annual production is 200,000 tons of brown coal-tar from 1,500,000 tons of briquettes. The tar is to be hydrogenated to benzine in a new plant, Hydrierwerke A.G., erected at the same place. Most of the coke is used in the powdered coal furnaces of the Böhlen power plants and the rest is used in producing hydrogen for the new hydrogenation plant.

An interesting process for the cold fractionation of heavy petroleum and petroleum residues has been developed by St. v. Pilat. Fundamentally it is a continuation of Holde's process which precipitated the asphalt content of the petroleum with light benzine. Pilat precipitates solutions of heavy petroleum in a propane-butane mixture, or actually with dry natural gas (97 per cent methane) without pressure. By increasing the pressure of the gas up to 30 atm. and higher it is possible to precipitate one fraction after another from the propane-butane solution, thus obtaining fractions which are lubricants with an exceptionally good viscosity index. The selective action of methane solutions on mineral oils can be increased by adding cresol. The French Patent 770903 with American priority of June 10, 1933, contains a similar of the American Development Company. Using Pilat's process, Polish, Rumanian, Colombian and Venezuelan residues were fractionated without difficulty.

The fine-zinc plant of the Berzelius Metallhuetten Ges. in Duisburg-Wanheim, which was completed some time ago, is the largest of its kind. It produces daily 20 tons of fine zinc with a 99.994 per cent zinc content. Preceding from the experience of the New Jersey Zinc Co. with fractional distillation, they are using carborundum columns in Duisburg. Two columns are used to remove the lead and one to remove the cadmium. The plates (1 m. long) in the columns have openings alternately in the bottoms; the zinc runs down through them countercurrent to the zinc vapors. The lower half of the column is heated. Zinc which has been refined previously runs into the lead columns slightly above the heated portion. The upper part of the "lead columns" acts as a reflux condenser.

The zinc vapors which stream out of the top of the lead columns and which always contain cadmium are condensed in nearby condensers. The zinc flows through a channel into the cadmium column. The zinc and cadmium vapors coming out of the cadmium column enter a condenser which stands on the column. A tin box is attached to the condenser and the cadmium vapors are condensed in it. A portion of the zinc impurities (lead, copper, iron, and tin) flow out of the lead column through a sluice-like sump; the fine zinc comes out of the base of the cadmium column. The three columns and the refining furnace are heated with gas and the air is preheated by three regenerators of Bender construction. The operating temperature in the lead columns is 1,220 deg. C. and in the cadmium column 1,140 deg. C.

## Haylett Heads Committee On Refinery Technology

C. E. Haylett, of the Union Oil Co. of California, Los Angeles, has been appointed chairman of the American Petroleum Institute's Central Committee on Refinery Technology for 1936. Dr. R. P. Anderson, secretary of the Institute's Division of Refining, again is secretary. Members of the committee for 1936 are: D. G. Brandt, Cities Service Co., New York; H. W. Camp, Empire Oil & Refining Co., Tulsa, Okla.; T. G. Delbridge, The Atlantic Refining Co., Philadelphia, Pa.; R. A. Halloran, Standard Oil Co. of California, San Francisco; E. W. Isom, Sinclair Refining Co., New York; Emby Kaye, Skelly Oil Co., Tulsa; N. E. Loomis, Standard Oil Co. of New Jersey, New York, and K. G. Mackenzie, The Texas Co., New York. Also J. T. McCoy, Tide Water Oil Co., Bayonne, N. J.; Walter Miller, Continental Oil Co., Ponca City, Okla.; John W. Newton, Magnolia Petroleum Co., Beaumont, Texas; G. G. Oberfell, Phillips Petroleum Co., Bartlesville, Okla.; R. C. Osterstrom, The Pure Oil Co., Chicago, Ill.; A. E. Pew, Jr., Sun Oil Co., Philadelphia; J. B. Rather, Socony-Vacuum Oil Co., New York; Herschel G. Smith, Gulf Refining Co., Philadelphia; F. W. Sullivan, Jr., Standard Oil Co. (Indiana), Chicago; F. W. L. Tydeman, Shell Development Co., San Francisco, and H. D. Wilde, Jr., Humble Oil & Refining Co., Houston, Texas.

# NAMES *in the News*

Norman W. Krase, for the past ten years associate professor of chemical engineering at the University of Illinois, announces he is to have charge of chemical engineering at the University of Pennsylvania, beginning in the fall of 1936. He will build up facilities and continue his research in the field of high-pressure reactions, giving particular attention to the development of graduate work. Professor Krase served as a consulting editor of *Chem. & Met.* in 1930.

A. A. Potter, dean of the School of Engineering, Purdue University, has been elected president of the American Engineering Council for 1936. As president, he succeeds Dr. J. F. Coleman, consulting engineer of New Orleans.

Edward R. Weidlein, head of Mellon Institute, has been selected president-elect of the American Chemical Society for 1936.

Alden H. Emery, who has for a number of years been assistant chief engineer of the Experimntal Stations Division, Bureau of Mines, has been appointed assistant manager of the American Chemical Society. He will assume his duties as an aid to Dr. C. L. Parsons, April 1.

Frank G. Moore has been appointed division traffic manager of the Columbia Chemical Division of the Pittsburgh Plate Glass Co. and the Columbia Alkali Corp. He will continue as traffic manager of Southern Alkali Corp., and will have headquarters at Barberton, Ohio.

Roger Adams, head of the chemical department at the University of Illinois, has been awarded the Willard Gibbs Medal of the Chicago Section of the American Chemical Society.

H. C. Klipstein is president and L. C. Hughes is secretary and treasurer of the newly organized Carbogen Chemical Co. of Garwood, N. J., offering synthetic resins and compositions for use in paint and varnish production. Mr. Hughes will continue his consulting practice.

William M. Rand has been elected president of Monsanto Chemical Co.'s subsidiary Merrimac Chemical Co. at Everett, Mass. He succeeds Charles Belknap, who recently moved to St. Louis, headquarters of the parent company as executive vice-president.

**Norman W. Krase**

Lauren B. Hitchcock has resigned as professor in charge of the course in chemical engineering at the University of Virginia to join the Hooker Electrochemical Co. January 1 as consulting chemical engineer.

J. F. Johnson, formerly fuel analyst for the Florida East Coast Railway, has been appointed inspector of tests for the same company. N. M. Eberhart has been appointed fuel analyst.

Iver Igelsrud, an industrial water supply specialist, has been added to the staff of Battelle Memorial Institute. Other recent additions to the staff are: Wilbur H. Bachman, Joel C. Carpenter and Alfred Boyles.

J. J. Durrett has been reappointed chief of the Drug Division of the Food and Drug Administration, W. G. Campbell, chief of the Administration, recently announced. Dr. Durrett returns to his former post after an absence of four years. During that period he was associated with E. R. Squibb & Sons of New York.

A. P. Nutter has left the Brown Co. to become associated with the Upson Co. at Lockport, N. Y., as works engineer.

George D. Beal, assistant director of the Mellon Institute, has been appointed president of the American Pharmaceutical Association for the year 1936-37. This honor has come to Dr. Beal in recognition of his achievements in pharmaceutical chemistry.

E. Dana Durand, chief economist of the Tariff Commission since 1930, and formerly a member of the staff of the Department of Commerce, has been named by the President a member of the Tariff Commission for a term ending in 1940. In view of Dr. Durand's long career of service to the government, it is anticipated that his appointment will be promptly confirmed by the Senate in January.

William Mansfield Clark, professor of physiological chemistry in Johns Hopkins School of Medicine, has been awarded the William H. Nichols Medal of the New York Section of the American Chemical Society. It will be presented March 6.

## OBITUARY

John Marshall Topham, general superintendent of manufacturing operations of the Carbide & Carbon Chemicals Corp. centering in South Charleston, W. Va., died November 20, following an operation for acute appendicitis.

Raymond E. Daly, Jr., died suddenly, following a brief illness, in his home at Hammond, Ind., on Decmber 3. He was 32 years of age.

Mr. Daly received his training in chemical engineering at the Universities of Illinois and Chicago. In 1930, he started his career with the American Maize-Products Co.; his rise was rapid and two years later he was made assistant director of research. He worked in several of the plant departments and was responsible for many improvements, particularly in the processing of lactic acid; the manufacture of cereal sugar; and in protein feed production. In 1935, he was made assistant to the general manager in charge of operations.

William K. Alsop died at his home at Ridgway, Pa., January 5, of a heart attack. He was 63 years old and had been ill a week. For many years he was chief chemist for the United States Leather Co.

Frederick Rayfield died November 28. For many years prior to his retirement he served as head of the fertilizer department of Swift & Co.

David J. Lewis died December 26 in his home at South Orange, N. J., following a long illness. He was 78 years old on Christmas Day. Mr. Lewis will be remembered for his contributions to improvements of chemical engineering equipment. He was a pioneer in the centrifugal field having invented many improvements in design and construction of the basket type.

# *Chemical* ECONOMICS

INCREASES in industrial outputs are reported by the indexes of the Federal Reserve Board. According to this compilation industrial production advanced from 95 per cent of the 1923-1925 average in October to 97 per cent in November. Adjusted for seasonal variation, the new index figure was the highest in several years and compared with 75 per cent for November, 1934.

In its summary, based upon statistics for November and the first three weeks of December, the board pointed out that industrial production and equipment usually decline at this season. The board also called attention to a more than seasonal increase in the distribution of commodities to consumers.

The new high level reflected the continued increase in the output of industries producing durable goods, according to the summary which explained that activity in most other industries declined somewhat in November.

Output of steel increased further during November to a higher rate than in any previous month this year, the index reaching 96 per cent as compared with 88 per cent for October. This high level was maintained during the first three weeks of December, the summary said, adding:

Automobile production in November continued the sharp increase which began after the change to new models in September.

Activity at silk mills and at woolen mills declined.

Factory employment and pay rolls, which usually decline from the middle of October to the middle of November, showed little change for that period this year.

Consumption of crude rubber in this country established a new record last year. Official figures are not yet available for December but consumption for the first eleven months of 1935 amounted to 454,208 long tons. For the twelve months of 1929—the previous record year—domestic consumption of rubber was 469,804 long tons. Trade estimates place consumption for last December at close to 42,000 long tons, so the total for 1935 should figure out around 496,000 long tons.

Automobile tire production has been running unusually heavy for this time of year due to the stepping up of automotive production. Prospects for tire production favor a gain in output for 1936 over 1935 but this is contingent on production of cars on present estimated schedules as replacement buying of tires will fall short of its 1935 volume.

Wool consumption which for the first nine months of last year ran 31 per cent larger than the total for the twelve months of 1934 was in active demand throughout the year. The peak was reached in October with a consumption of 29,564,000 lb. scoured basis. A drop to 27,528,000 lb. followed in November but it is necessary to go back twelve years to find a month where consumption was so large—with the exception of October, 1935.

An average increase of about 6 per cent in the movement of commodities for the first quarter of this year is indicated by the forecast made by the 13 shippers regional advisory boards. All sections of the country are expected to share in the increase with the exception of New England where a decline of 0.3 per cent is anticipated because of reduced shipments of potatoes. Of the 29 commodities listed, increases are shown for all but four and they are all agricultural products.

Among the specified commodities, the rates of increases in shipments for the quarter include: cottonseed and products except oil, 4.5 per cent; coal and coke, 1.8 per cent; salt, 7.2 per cent; petroleum and products, 4.2 per cent; fertilizers, 0.8 per cent; paper and pulp, 9.5 per cent; chemicals and fertilizers, 3.8 per cent.

The tanning industry was reported to be quite active in the closing months of the year. Demand for leather was sufficient to take large amounts into consumption. This is borne out by the report that an all-time record was made last year in production of shoes, the output reaching about 368,000,000 pairs which surpassed the 1929 total by approximately 6,500,000 pairs and exceeded the 1934 figure by more than 11,000,000 pairs. As the large total for 1935 was attributed to unusually large operations in the last four months of the year, the position of the tanning trade may be judged accordingly.

Disregarding the usual seasonal trend, exports of chemicals and allied products continued at peak levels in November bringing the total for the first eleven months of the year to $125,000,000, according to the Commerce Department's Chemical Division.

The total value of such exports during November aggregated $13,136,500—a record that has been exceeded only once in recent years—and was 20 per cent higher than in November, 1934, when chemical export shipments amounted to $11,022,000.

The high figure attained was due largely to heavier shipments of dyes, medicinals, industrial chemicals and chemical specialties, mixed paints, varnishes, and lacquers, carbon black, toilet preparations and potassium and nitrogen fertilizers, preliminary statistics show.

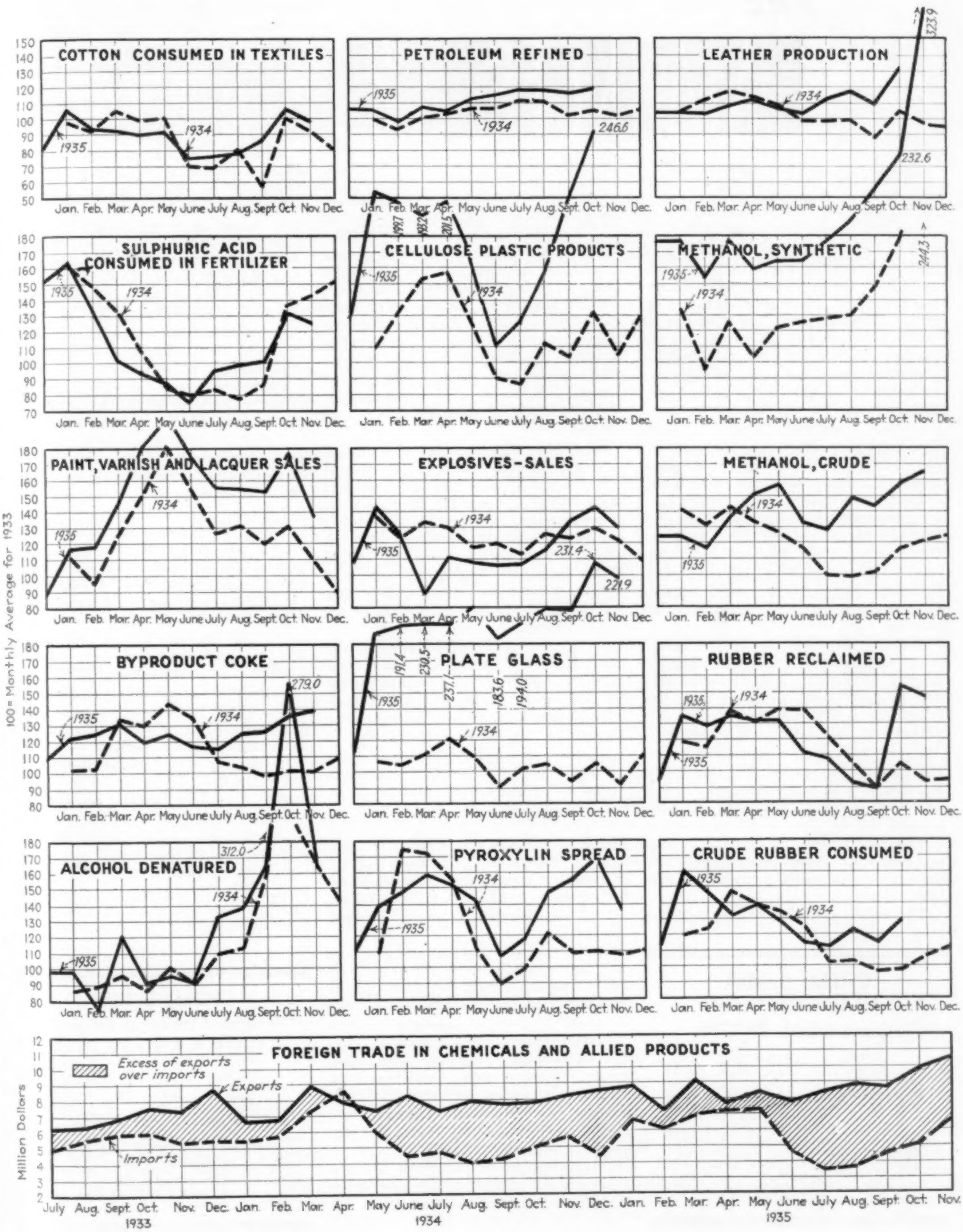
Fertilizers made the most spectacular gain during the month with export shipments valued at $1,895,100 compared with $1,162,600 during November, 1934. Practically all classes increased both in quantity and value, statistics show. Nitrogens were almost double November, 1934, shipments and potash increased from only 1,500 tons valued at $45,800, to 11,035 tons valued at $347,260.

**Production and Consumption Data for Chemical-Consuming Industries**

| Production | Nov. 1935 | Nov. 1934 | Jan.-Nov. 1935 | Jan.-Nov. 1934 | Gain Jan.-Nov. 1935 over Jan.-Nov. 1934 Per Cent |
|---|---|---|---|---|---|
| Alcohol, denatured, 1,000 wi.gal | 10,297 | 10,316 | 89,546 | 86,606 | 3.4 |
| Automobiles, No. | 389,024 | 83,482 | 3,602,090 | 2,599,487 | 38.6 |
| Byproduct coke, 1,000 tons | 3,116 | 2,267 | 30,905 | 28,415 | 8.8 |
| Glass containers, 1,000 gr | 3,275 | 2,864 | 35,718 | 32,741 | 9.1 |
| Plate glass, 1,000 sq.ft | 15,909 | 6,587 | 163,704 | 83,418 | 96.2 |
| Methanol, crude, gal | 424,149 | 309,739 | 4,011,632 | 3,407,040 | 17.7 |
| Methanol, synthetic, gal | 2,373,475 | 1,789,970 | 16,392,135 | 11,232,583 | 45.9 |
| Cellulose-acetate plastics, 1,000 lb | 1,265 | 304 | 9,556 | 4,361 | 119.1 |
| Nitro-cellulose plastics, 1,000 lb | 1,301 | 948 | 14,749 | 11,271 | 30.8 |
| Pyroxylin spread, 1,000 lb | 4,152 | 3,256 | 47,668 | 40,575 | 17.5 |
| Rubber reclaimed, tons | 11,482 | 7,268 | 30,279 | 22,385 | 35.3 |
| Steel barrel, No. | 631,307 | 467,699 | 6,347,742 | 6,254,337 | 1.5 |
| Sulphuric acid in fertilizer trade, tons | 153,792 | 159,781 | 1,481,862 | 1,347,452 | 9.9 |
| **Consumption** | | | | | |
| Cotton, 1,000 bales | 508 | 477 | 5,133 | 5,001 | 2.6 |
| Silk, bales | 37,012 | 37,548 | 461,584 | 420,765 | 9.7 |
| Explosives, sales, 1,000 lb | 26,876 | 25,108 | 259,788 | 270,834 | 4.1* |
| Paint, varnish, and lacquer, sales, $1,000 | 25,607 | 19,801 | 314,419 | 260,200 | 20.8 |
| Sulphuric acid in fertilizer trade, tons | 125,109 | 143,282 | 1,210,436 | 1,243,781 | 2.7* |

*Per cent of decline.

# TRENDS OF PRODUCTION AND CONSUMPTION



# The MARKETS

THERE WAS a tapering off in activities, in the latter part of the year and in the first part of January, on the part of industries which are large consumers of chemicals and trading in raw materials took on a corresponding aspect. There still is some interest in contract business as all buyers are not covered ahead but general contract placements have been quite satisfactory to producers but in a few cases—and this includes one or two of the more important chemicals—buyers have delayed covering future requirements because of belief that competitive conditions will bring about lower price levels.

On the other hand, many buyers have increased commitments over those of a year ago because of confidence in larger consuming markets this year and in the case of a few materials, the volume of contracts has been expanded because the prices quoted were regarded as attractive.

Nothing developed in the last month which might be interpreted as having a bearing on future prices for chemicals. The outlook favors a decline in a few cases with a strong market for the vast majority of chemical prices. The AAA decision, however, has created an uncertain price position in the commodity markets and this probably will find a reflection in values for animal fats. Cottonseed oil also may be affected should planting of cotton be unrestricted and cottonseed oil values have considerable influence on prices for many other vegetable oils.

The recent lowering of the tariff on acetic acid from Canada has given an advantage to the Canadian material and it is interesting to note that imports of acetic acid for the first ten months of last year were 29,203,138 lb. compared with 21,364,433 lb. for the corresponding period of 1934. Recently there has been some price cutting in acetic acid in the New England territory but this was explained on the ground that limited amounts of this acid of wood distillation origin were pressed for sale in that territory.

It is interesting to note, by statistics, that the United States which only a few years ago was entirely dependent upon foreign sources for its potash requirements has now become an important exporter of this fertilizer material. Shipments of potash from the United States during the first eleven months of 1935 amounted to almost 65,000 tons valued at $1,856,000, according to official statistics.

Developments abroad include a report to the effect that importation into France of 40,000 metric tons of Chilean nitrate of soda for use during the 1935-36 agricultural year has just been authorized by the Minister of Agriculture.

This amount, it is pointed out, is the Chilean share of the 50,000-ton quota recently fixed, the remainder being allotted to Norway.

Of the 40,000 metric tons, 27,500 tons will be allocated to the National Federation of Agricultural Co-operatives for distribution among the agricultural associations and 12,500 tons will be reserved for distribution among fertilizer dealers.

It also was reported that an agreement had been made between the Irish Free State and the Czechoslovakian firm of Skoda Works Limited, which will result in establishing and equipping five industrial alcohol distilleries in Ireland. The distilleries will be located at Riverstown, Cooley, County Louth; Carrickmacross, County Monoghan; Carndonagh and Corkay, both in County Donegal; and Corroy, Ballina, County Mayo, and will cost approximately £75,000.

Press reports on the Irish Government's plans regarding the production and use of industrial alcohol point out that if a 10 percent mixture of alcohol is legally required for motor fuel, a potential home market for about 4,000,000 gal. of industrial alcohol exists, providing an outlet for over 20,000 acres of potatoes.

Heat and excessive rains early in December are believed to have damaged the Argentine flaxseed crop to such an extent that the official estimate of production made by the Government on Dec. 20 will have to be reduced substantially.

The first official estimate for the 1935-36 flaxseed crop was for a crop of 50,391,000 bushels compared with 79,720,000 bushels last year. This estimate according to Mr. Nyhus was probably right when compiled, but it is believed to be too high at this time. The crop did well during November and in spite of weeds and excessive rains, fair to good yields were being harvested early in December in the Provinces of Cordoba, Santa Fe, and Entre Rios. While the seeds were plump, there was a considerable proportion of stained and green seeds, weed seeds, and other foreign matter due to frequent rains. Recent reports indicate, however, that owing to continued excessive rains the crop in the Provinces of Cordoba and Santa Fe was deteriorating to an alarming degree.

The area planted to flaxseed this season was only 6,573,000 acres compared with 8,102,000 acres in 1934-35 and a 5-year average of 7,499,000 acres for 1929-30 to 1933-34. This represents a reduction of almost 19 per cent compared with last year's sown acreage and 12 per cent compared with average sowings. Since the figures are for sown acreage, they include some which is admitted to be a total failure, especially in the Province of Entre Rios and in the Territory of La Pampa.

As this country is dependent on the Argentine for a large part of its linseed supply, the prices quoted in domestic markets for linseed oil will be sensitive to fluctuations in the Argentine seed markets. With the outlook favoring a larger use of linseed oil in the present year, a less-than-normal Argentine seed supply would have more than usual price influence on the oil market.

## CHEM. & MET.
### Weighted Index of CHEMICAL PRICES

Base = 100 for 1927

| | |
|---|---|
| **This month** | **87.21** |
| Last month | 87.35 |
| January, 1935 | 87.53 |
| January, 1934 | 87.86 |

The majority of the chemical list held an unchanged position throughout the month but some of the metal salts were lower in price. Anti-freeze alcohol was reduced rather sharply and for a part of the month turpentine was in a weak position.

## CHEM. & MET.
### Weighted Index of Prices for OILS AND FATS

Base = 100 for 1927

| | |
|---|---|
| **This month** | **92.36** |
| Last month | 93.05 |
| January, 1935 | 86.64 |
| January, 1934 | 51.38 |

Animal fats in general were easier in price with a spotty market for vegetable oils. Linseed oil held firm but China wood oil declined in value and crude cottonseed oil was fractionally lower.

# *Current* PRICES

**The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to Jan. 13.**

## Industrial Chemicals

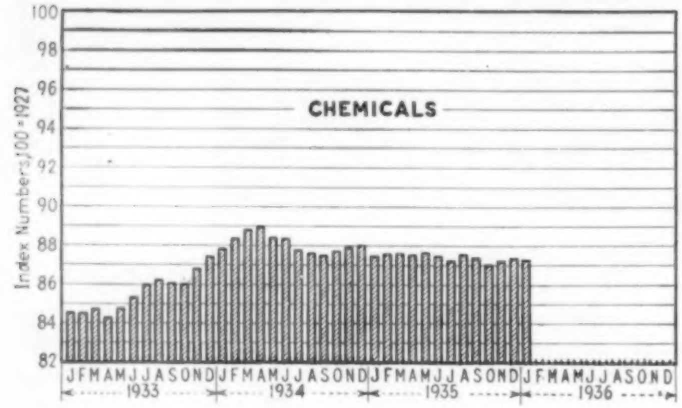
| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Acetone, drums, lb | $0.12 -$0.12½ | $0.12 -$0.12½ | $0.12 -$0.12½ |
| Acid, acetic, 28%, bbl., cwt | 2.45 - 2.70 | 2.45 - 2.70 | 2.40 - 2.55 |
| Glacial 99%, drums | 8.43 - 8.68 | 8.43 - 8.68 | 8.25 - 8.50 |
| U. S. P. reagent | 10.52 -10.77 | 10.52 -10.77 | 10.52 -10.77 |
| Boric, bbl., ton | 105.00-115.00 | 105.00-115.00 | 95.00 -105.00 |
| Citric, kegs, lb | .28 - .31 | .28 - .31 | .28 - .31 |
| Formic, bbl., ton | .11 - .11½ | .11 - .11½ | .11 - .11½ |
| Gallic, tech., bbl., lb | .60 - .65 | .60 - .65 | .60 - .65 |
| Hydrofluoric 30% carb., lb | .07 - .07½ | .07 - .07½ | .07 - .07½ |
| Latic, 44%, tech., light, bbl., lb | .12 - .12½ | .12 - .12½ | .12 - .12½ |
| 22%, tech., light, bbl., lb | .06½- .07 | .06½- .07 | .06½- .07 |
| Muriatic, 18°, tanks, cwt | 1.00 - 1.10 | 1.00 - 1.10 | 1.00 - 1.10 |
| Nitric, 36°, carboys, lb | .05 - .05½ | .05 - .05½ | .05 - .05½ |
| Oleum, tanks, wks., ton | 18.50 -20.00 | 18.50 -...... | 18.50 -20.00 |
| Oxalic, crystals, bbl., lb | .11⅞- .12⅞ | .11⅞- .12⅞ | .11⅞- .12⅞ |
| Phosphoric, tech., c'bys., lb | .09 - .10 | .09 - .10 | .09 - .10 |
| Sulphuric, 60°, tanks, ton | 11.00 -11.50 | 11.00 -11.50 | 11.00 -11.50 |
| Sulphuric, 66°, tanks, ton | 15.50 -...... | 15.50 -...... | 15.50 -...... |
| Tannic, tech., bbl., lb | .23 - .35 | .23 - .35 | .23 - .35 |
| Tartaric, powd., bbl., lb | .24 - .25 | .24 - .25 | .24 - .25 |
| Tungstic, bbl., lb | 1.50 - 1.60 | 1.50 - 1.60 | 1.40 - 1.50 |
| Alcohol, Amyl | ......-...... | ......-...... | ......-...... |
| From Pentane, tanks, lb | .15 -...... | .15 -...... | .143-...... |
| Alcohol, Butyl, tanks, lb | .12 -...... | .12 -...... | .12 -...... |
| Alcohol, Ethyl, 190 p'f., bbl., gal | 4.27½-...... | 4.27½-...... | 4.15½-...... |
| Denatured, 190 proof | | | |
| No. 1 special, dr., gal. | .36 -...... | .36 -...... | .346-...... |
| No. 5, 188 proof, dr., gal | .35½-...... | .35½-...... | .34 -...... |
| Alum, ammonia, lump, bbl., lb | .03 - .04 | .03 - .04 | .03 - .04 |
| Chrome, bbl., lb | .04½- .05 | .04½- .05 | .04½- .05 |
| Potash, lump, bbl., lb | .03¼- .04 | .03 - .04 | .03 - .04 |
| Aluminum sulphate, com., bags cwt | 1.35 - 1.50 | 1.35 - 1.50 | 1.35 - 1.50 |
| Iron free, bg., cwt | 1.90 - 2.00 | 1.90 - 2.00 | 1.90 - 2.00 |
| Aqua ammonia, 26°, drums, lb | .02½- .03 | .02½- .03 | .02½- .03 |
| tanks, lb | .02½- .02¾ | .02½- .02¾ | .02½- .02¾ |
| Ammonia, anhydrous, cyl., lb | .15½- .16 | .15½- .16 | .15½- .16 |
| tanks, lb | .04½-...... | .04½-...... | .04½-...... |
| Ammonium carbonate, powd. tech., casks, lb | .08 - .12 | .08 - .12 | .08 - .12 |
| Sulphate, wks., cwt | 1.20 -...... | 1.20 -...... | 1.20 -...... |
| Amylacetate tech., tanks, lb | .142-...... | .142-...... | .142-...... |
| Antimony Oxide, bbl., lb | .14 - .14¾ | .14 .14¾ | .10½. .10¾ |
| Arsenic, white, powd., bbl., lb | .03½- .04 | .03½- .04 | .03½- .04 |
| Red, powd., kegs, lb | .15¾- .16 | .15¾- .16 | .15¾- .16 |
| Barium carbonate, bbl., ton | 56.50 -58.00 | 56.50 -58.00 | 56.50 -58.00 |
| Chloride, bbl., ton | 72.00 -74.00 | 72.00 -74.00 | 74.00 -75.00 |
| Nitrate, cask, lb | .08½- .09 | .08½- .09 | .08½- .09 |
| Blanc fixe, dry, bbl., lb | .03½- .04 | .03½- .04 | .03½- .04 |
| Bleaching powder, f.o.b., wks., drums, cwt | 2.00 - 2.10 | 2.00 - 2.10 | 1.90 - 2.00 |
| Borax, gran., bags, ton | 44.00 -49.00 | 44.00 -49.00 | 40.00 -45.00 |
| Bromine, cs., lb | .36 - .38 | .36 - .38 | .36 - .38 |
| Calcium acetate, bags | 2.10 -...... | 2.10 -...... | 2.00 -...... |
| Arsenate, dr., lb | .06 - .07 | .06 - .07 | .06 - .07 |
| Carbide drums, lb | .05 - .06 | .05 - .06 | .05 - .06 |
| Chloride, fused, dr., del., ton | 20.00 -33.00 | 20.00 -33.00 | 17.50 -...... |
| flake, dr., del., ton | 22.00 -35.00 | 22.00 -35.00 | 19.50 -...... |
| Phosphate, bbl., lb | .07½- .08 | .07½- .08 | .07½- .08 |
| Carbon bisulphide, drums, lb | .05½- .08½ | .05½- .06 | .05½- .06 |
| Tetrachloride drums, lb | .05¼- .08½ | .05¼- .06 | .05¼- .06 |
| Chlorine, liquid, tanks, wks., lb | 2.15 -...... | 2.15 -...... | 2.00-...... |
| Cylinders | .05½- .06 | .05½- .06 | .05½- .06 |
| Cobalt oxide, cans, lb | 1.39 - 1.45 | 1.39 - 1.45 | 1.25 - 1.30 |

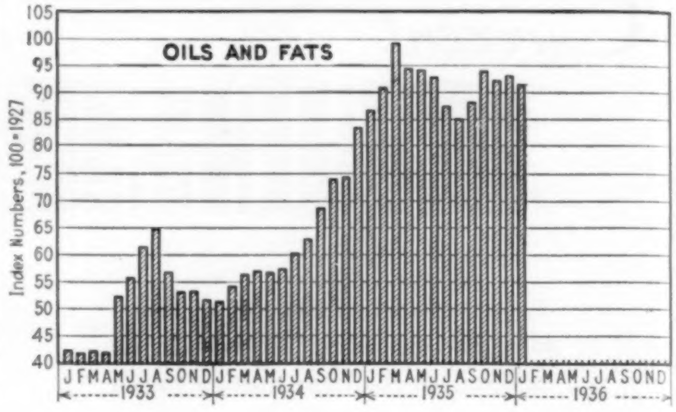
| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Copperas, bgs., f.o.b., wks., ton | 15.00 -16.00 | 15.00 -16.00 | 14.00 -15.00 |
| Copper carbonate, bbl., lb | .08¾- .16 | .08¾- .16 | .08¾- .16 |
| Cyanide, tech., bbl., lb | .37 - .38 | .37 - .38 | .37 - .38 |
| Sulphate, bbl., cwt | 3.85 - 4.00 | 3.85 - 4.00 | 3.85 - 4.00 |
| Cream of tartar, bbl., lb | .16¾- .17 | .16¾- .17 | .17¾- .18 |
| Diethylene glycol, dr., lb | .16½- .20½ | .16½- .20½ | .14 - .16 |
| Epsom salt, dom., tech., bbl., cwt | 2.10 - 2.15 | 2.10 - 2.15 | 2.10 - 2.15 |
| Imp., tech., bags, cwt | 2.00 - 2.10 | 2.00 - 2.10 | 2.00 - 2.10 |
| Ethyl acetate, drums, lb | .08½-...... | .08½-...... | .08½-...... |
| Formaldehyde, 40 %, bbl., lb | .06 - .07 | .06 - .07 | .06 - .07 |
| Furfural, dr., contact, lb | .10 - .17½ | .10 - .17½ | .10 - .17½ |
| Fusel oil, crude, drums, gal | .75 -...... | .75 -...... | .75 -...... |
| Refined, dr., gal | 1.25 - 1.30 | 1.25 - 1.30 | 1.25 - 1.30 |
| Glaubers salt, bags, cwt | 1.00 - 1.10 | 1.00 - 1.10 | 1.00 - 1.10 |
| Glycerine, c.p., drums, extra, lb | .14 - .14½ | .14 - .14½ | .14 - .14½ |
| Lead: | | | |
| White, basic carbonate, dry casks, lb | .06½-...... | .06½-...... | .06½-...... |
| White, basic sulphate, sck., lb | .06 -...... | .06 -...... | .06 -...... |
| Red, dry, sck., lb | .07 -...... | .07 -...... | .06 -...... |
| Lead acetate, white crys., bbl., lb | .10½- .11 | .10½- .11 | .10½- .11 |
| Lead arsenate, powd., bbl., lb | .09 - .10 | .09 - .10 | .09 - .10 |
| Lime, chem., bulk, ton | 8.50 -...... | 8.50 -...... | 8.50 -...... |
| Litharge, pwd., csk., lb | .06 -...... | .06 -...... | .05¾-...... |
| Lithophone, bags, lb | .04½- .05 | .04½- .05 | .04½- .05 |
| Magnesium carb., tech., bags, lb | .06 - .06½ | .06 - .06½ | .06 - .06½ |
| Methanol, 95%, tanks, gal | .33 -...... | .33 -...... | .33 -...... |
| 97%, tanks, gal | .34 -...... | .34 -...... | .34 -...... |
| Synthetic, tanks, gal | .35½-...... | .35½-...... | .35½-...... |
| Nickel salt, double, bbl., lb | 13. - .13½ | .13 - .13½ | .12½- .13 |
| Orange mineral, csk., lb | .10 -...... | .10 -...... | .09 -...... |
| Phosphorus, red, cases, lb | .44 - .45 | .44 - .45 | .44 - .45 |
| Yellow, cases, lb | .28 - .32 | .28 - .32 | .28 - .32 |
| Potassium bichromate, casks, lb | .08½- .09 | .08½- .09 | .07¾- .08½ |
| Carbonate, 80-85%, calc. csk., lb | .07 - .07½ | .07 - .07½ | .07 - .07½ |
| Chlorate, powd., lb | .08¾- .09 | .08¾- .09 | .09½- .10 |
| Hydroxide(c'stic potash) dr., lb | .06¼- .06½ | .06¼- .06½ | .06¼- .06½ |
| Muriate, 80% bgs., ton | 22.00 -...... | 22.00 -...... | 22.00 -...... |
| Nitrate, bbl., lb | .05½- .06 | .05½- .06 | .05½- .06 |
| Permanganate, drums, lb | .18½- .19 | .18½- .19 | .18½- .19 |
| Prussiate, yellow, casks, lb | .18 - .19 | .18 - .19 | .18 - .19 |
| Sal ammoniac, white, casks, lb | .04½- .05 | .04½- .05 | .04½- .05 |
| Salsoda, bbl., cwt | 1.00 - 1.05 | 1.00 - 1.05 | 1.00 - 1.05 |
| Salt cake, bulk, ton | 13.00 -15.00 | 13.00 -15.00 | 13.00 -15.00 |
| Soda ash, light, 58%, bags, contract, cwt | 1.23 -...... | 1.23 -...... | 1.23 -...... |
| Dense, bags, cwt | 1.25 -...... | 1.25 -...... | 1.25 -...... |
| Soda, caustic, 76%, solid, drums, contract, cwt | 2.60 - 3.00 | 2.60 - 3.00 | 2.60 - 3.00 |
| Acetate, works, bbl., lb | .04¾- .05 | .04¾- .05 | .04¾- .05 |
| Bicarbonate, bbl., cwt | 1.85 - 2.00 | 1.85 - 2.00 | 1.85 - 2.00 |
| Bichromate, casks, lb | .06½- .07 | .06½- .07 | .05¾- .06¾ |
| Bisulphate, bulk, ton | 15.00 -16.00 | 15.00 -16.00 | 14.00 -16.00 |
| Bisulphite, bbl., lb | .03½- .04 | .03½- .04 | .03 - .04 |
| Chlorate, kegs, lb | .06¼- .06½ | .06¼- .06½ | .06¼- .06½ |
| Chloride, tech., ton | 12.00 -14.75 | 12.00 -14.75 | 12.00 -14.75 |
| Cyanide, cases, dom., lb | .15½- .16 | .15½- .16 | .15½- .16 |
| Fluoride, bbl., lb | .07½- .08 | .07½- .08 | .07½- .08 |
| Hyposulphite, bbl., lb | 2.40 - 2.50 | 2.40 - 2.50 | 2.40 2.50 |
| Metasilicate, bbl., cwt | 3.25 - 3.40 | 3.25 - 3.40 | 3.25 - 3.40 |
| Nitrate, bags, cwt | 1.275-...... | 1.275-...... | 1.24 -...... |
| Nitrite, casks, lb | .07½- .08 | .07½- .08 | .07½- .08 |
| Phosphate, dibasic, bbl., lb | .022- .023 | .022- .023 | .022- .024 |
| Prussiate, yel. drums, lb | .11½- .12 | .11½- .12 | .11½- .12 |
| Silicate (40° dr.) wks., cwt | .80 - .85 | .80 - .85 | .80 - .85 |
| Sulphide, fused, 60-62%, dr., lb | .02¾- .03½ | .02¾- .03 | .02¾- .03 |
| Sulphite, cyrs., bbl., lb | .02¼- .02½ | .02¼- .02½ | .02¼- .02½ |
| Sulphur, crude at mine, bulk, ton | 18.00 -...... | 18.00 -...... | 18.00 -...... |
| Chloride, dr., lb | .03½- .04 | .03½- .04 | .03½- .04 |
| Dioxide, cyl, lb | .07 - .07½ | .07 - .07½ | .07 - .07½ |
| Flour, bag, cwt | 1.60 - 3.00 | 1.60 - 3.00 | 1.60 - 3.00 |
| Tin Oxide, bbl., lb | .52 -...... | .54 -...... | .56 -...... |
| Crystals, bbl., lb | .36½-...... | .37½-...... | .38 -...... |
| Zinc chloride, gran., bbl., lb | .05 - .06 | .05 - .06 | .05½- .06 |
| Carbonate, bbl., lb | .09 - .11 | .09 - .11 | .09½- .11 |
| Cyanide, dr., lb | .36 - .38 | .36 - .38 | .38 - .42 |
| Dust, bbl., lb | .069- .07 | .069- .07 | .057- .07 |
| Zinc oxide, lead free, bag, lb | .05 -...... | .05 -...... | .06¼-...... |
| 5% lead sulphate, bags, lb | .04¾-...... | .04¾-...... | .06¼-...... |
| Sulphate, bbl., cwt | 2.65 - 3.00 | 2.65 - 3.00 | 2.75 - 3.00 |

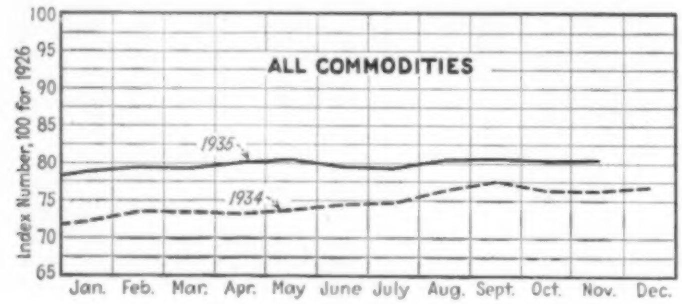
## Oils and Fats

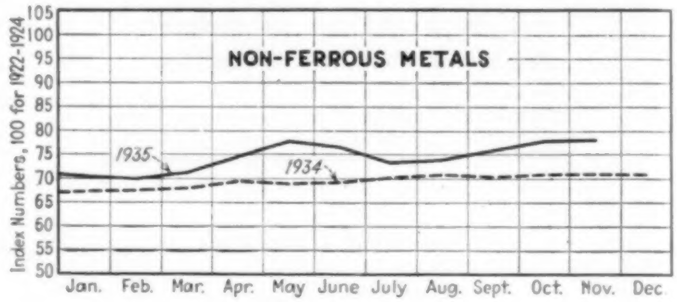
| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Castor oil, No. 3, bbl., lb | $0.10 -$0.11 | $0.10 -$0.11 | $0.09¾-$0.10 |
| Chinawood oil, bbl., lb | .14 -...... | .16½-...... | .092-...... |
| Coconut oil, Ceylon, tanks, N. Y. lb | .04¾-...... | .04¾-...... | .04¾-...... |
| Corn oil crude, tanks, (f.o.b mill), lb | .10 -...... | .10¾-...... | .09¾-...... |
| Cottonseed oil, crude (f.o.b. mill), tanks, lb | .08¾-...... | .09¾-...... | .09½-...... |
| Linseed oil, raw car lots, bbl., lb | .10 -...... | .095-...... | .089-...... |
| Palm, casks, lb | .04¾-...... | .04¾-...... | .03¾-...... |
| Palm kernel, bbl., lb | .05¼-...... | .05¼-...... | .04 -...... |
| Peanut oil, crude, tanks (mill), lb | .09 -...... | .09¾-...... | .09¾-...... |
| Rapeseed oil, refined, bbl., gal | .56 -...... | .54 -...... | .41 -...... |
| Soya bean, tank, lb | .08 -...... | .09 -...... | .07¾-...... |
| Sulphur (olive foots), bbl., lb | .08¾-...... | .09 -...... | .07¾-...... |
| Cod, Newfoundland, bbl., gal | .35 -...... | .35 -...... | .36 -...... |
| Menhaden, light pressed, bbl., lb | .072-...... | .072-...... | .055-...... |
| Crude, tanks(f.o.b.factory), gal | .36 -...... | .32 -...... | .25 -...... |
| Grease, yellow, loose, lb | .05¾-...... | .06 -...... | .05¾-...... |
| Oleo stearine, lb | .09½-...... | .11½-...... | .09¾-...... |
| Red oil, distilled, d.p. bbl., lb | .09¼-...... | .09¼-...... | .07½-...... |
| Tallow, extra, loose, lb | .06¾-...... | .06¾-...... | .05¾-...... |

# CHEM. & MET.'S WEIGHTED PRICE INDEXES




## Coal-Tar Products

| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Alpha-naphthol, crude, bbl., lb. | $0.60 –$0.65 | $0.60 –$0.65 | $0.60 –$0.62 |
| Refined, bbl., lb. | .80 – .85 | .80 – .85 | .80 – .85 |
| Alpha-naphthylamine, bbl., lb. | .32 – .34 | .32 – .34 | .32 – .34 |
| Aniline oil, drums, extra, lb. | .14½– .15 | .14½– .15 | .14½– .15 |
| Aniline salts, bbl., lb. | .24 – .25 | .24 – .25 | .24 – .52 |
| Benzaldehyde, U.S.P., dr., lb. | 1.10 – 1.25 | 1.10 – 1.25 | 1.10 – 1.25 |
| Benzidine base, bbl, lb. | .65 – .67 | .65 – .67 | .65 – .67 |
| Benzoic acid, U.S.P., kgs., lb. | .48 – .52 | .48 – .52 | .48 – .52 |
| Benzyl chloride, tech., dr., lb. | .30 – .35 | .30 – .35 | .30 – .35 |
| Benzol, 90%, tanks, works, gal. | .18 – .20 | .18 – .20 | .15 – .16 |
| Beta-naphthol, tech., drums, lb. | .24 – .27 | .24 – .27 | .22 – .24 |
| Cresol, U.S.P., dr., lb. | .11 – .11½ | .11 – .11½ | .11 – .11½ |
| Cresylic acid, 99%, dr., wks., gal. | .51 – .52 | .45 – .46 | .50 – .51 |
| Diethylaniline, dr., lb. | .55 – .58 | .55 – .58 | .55 – .58 |
| Dinitrophenol, bbl., lb. | .29 – .30 | .29 – .30 | .29 – .30 |
| Dinitrotoluen, bbl., lb. | .16 – .17 | .16 – .17 | .16 – .17 |
| Dip oil, 25%, dr., gal. | .23 – .25 | .23 – .25 | .23 – .25 |
| Diphenylamine, bbl., lb. | .38 – .40 | .38 – .40 | .38 – .40 |
| H-acid, bbl., lb. | .65 – .70 | .65 – .70 | .65 – .70 |
| Naphthalene, flake, bbl., lb. | .07 – .07½ | .07 – .07½ | .05½– .06 |
| Nitrobenzene, dr., lb. | .08½– .09 | .08½– .09 | .08½– .10 |
| Para-nitraniline, bbl., lb. | .51 – .55 | .51 – .55 | .51 – .55 |
| Phenol, U.S.P., drums, lb. | .14½– .15 | .14½– .15 | .14½– .15 |
| Picric acid, bbl., lb. | .30 – .40 | .30 – .40 | .30 – .40 |
| Pyridine, dr., gal. | 1.10 – 1.15 | 1.10 – 1.15 | 1.10 – 1.15 |
| Resorcinal, tech., kegs, lb. | .65 – .70 | .65 – .70 | .65 – .70 |
| Salicylic acid, tech., bbl., lb. | .40 – .42 | .40 – .42 | .40 – .42 |
| Solvent naphtha, w.w., tanks, gal. | .26 –...... | .26 –...... | .26 –...... |
| Tolidine, bbl., lb. | .88 – .90 | .88 – .90 | .88 – .90 |
| Toluene, tanks, works, gal. | .30 –...... | .30 –...... | .30 –...... |
| Xylene, com., tanks, gal. | .30 –...... | .30 –...... | .26 –...... |

## Miscellaneous

| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Barytes, grid., white, bbl., ton | $22.00–$25.00 | $22.00–$25.00 | $22.00–$25.00 |
| Casein, tech., bbl., lb. | .15 – .16 | .15 – .16 | .09½– .10 |
| China clay, dom., f.o.b. mine, ton | 8.00 –20.00 | 8.00 –20.00 | 8.00 –20.00 |
| Dry colors: | | | |
| Carbon gas, black (wks.), lb. | .04 – .20 | .04 – .20 | .04 – .20 |
| Prussian blue, bbl., lb. | .37 – .38 | .36½– .38 | .35½– .37 |
| Ultramarine blue, bbl., lb. | .10 – .26 | .06 – .32 | .06 – .32 |
| Chrome green, bbl., lb. | .26 – .27 | .26 – .27 | .26 – .27 |
| Carmine red, tins, lb. | 4.00 – 4.40 | 4.00 – 4.40 | 4.00 – 4.40 |
| Para toner, lb. | .80 – .85 | .80 – .85 | .80 – .85 |
| Vermilion, English, bbl., lb. | 1.58 – 1.60 | 1.52 – 1.55 | 1.56 – 1.60 |
| Chrome yellow, C. P., bbl., lb. | .12 – .14 | .14 – .16 | .15 – .15½ |
| Feldspar, No. 1 (f.o.b. N.C.), ton. | 6.50 – 7.50 | 6.50 – 7.50 | 6.50 – 7.50 |
| Graphite, Ceylon, lump, bbl., lb. | .07 – .08½ | .07 – .08½ | .07 – .08½ |
| Gum copal Congo, bags, lb. | .09 – .10 | .09 – .10 | .06 – .08 |
| Manila, bags, lb. | .09 – .10 | .09 – .10 | .16 – .17 |
| Damar, Batavia, cases, lb. | .15½– .16 | .15½– .16 | .16 – .16½ |
| Kauri No. 1 cases, lb. | .20 – .25 | .20 – .25 | .45 – .48 |
| Kieselguhr (f.o.b. N. Y.), ton | 50.00 –55.00 | 50.00 –55.00 | 50.00 –55.00 |
| Magnesite, calc, ton | 50.00 –...... | 50.00 –...... | 40.00 –...... |
| Pumice stone, lump, bbl., lb. | .05 – .07 | .05 – .08 | .05 – .07 |
| Imported, casks, lb. | .03 – .40 | .03 – .40 | .03 – .35 |
| Rosin, H., bbl. | 5.65 –...... | 5.30 –...... | 5.85 –...... |
| Turpentine, gal. | .50½–...... | .49 –...... | .56 –...... |
| Shellac, orange, fine, bags, lb. | .27 –...... | .28 –...... | .35 –...... |
| Bleached, bonedry, bags, lb. | .23½–...... | .24 – | .24 –...... |
| T. N. bags, lb. | .14½–...... | .16 – | .23 –...... |
| Soapstone (f.o.b. Vt.), bags, ton | 10.00 –12.00 | 10.00 –12.00 | 10.00 –12.00 |
| Talc, 200 mesh (f.o.b. Vt.), ton | 8.00 – 8.50 | 8.00 – 8.50 | 8.00 – 8.50 |
| 300 mesh (f.o.b. Ga.), ton | 7.50 –10.00 | 7.50 –10.00 | 7.50 –11.00 |
| 225 mesh (f.o.b. N. Y.), ton | 13.75 –...... | 13.75 –...... | 13.75 –...... |

# INDUSTRIAL NOTES

George R. Woods, 17 Battery Pl., New York, has been appointed American representative for the chrome hardening processes and patents of H. Van Der Horst, Ingenieursbureau "Lemet Chromium," Hilversum, Holland.

Process Management Co. has moved its offices from 405 Lexington Ave. to 120 East 41st St., New York.

Republic Steel Corp., Youngstown, Ohio, has appointed T. T. Johnson as sales metallurgist. Mr. Johnson is attached to the Birmingham, Ala. district.

Raymond Bros. Impact Pulverizer Co., Chicago, has appointed J. F. Benton as sales engineer operating from the Chicago office and specializing in the phosphate rock and fertilizer field.

Michiana Products Corp., Michigan City, Ind., has appointed H. C. Armin as its representative in New England and New York with present headquarters at 754 E. 23rd St., Brooklyn, N. Y.

J. P. Devine Mfg. Co., Mt. Vernon, Ill., on Jan. 1, opened a new district office at 416 Rand Bldg., Buffalo, under the charge of P. J. Cooney.

Struthers-Wells Co., Warren, Pa., have announced the appointment of Brance-Krachy Co., Inc., 1901 Carolina St., Houston, as their representatives in the East Texas territory.

Atlantic Refining Co., will add a gas polymerization plant of the thermal type to its refinery at Atreco, Texas. The plant will have a capacity of 1200 bbl. per day of polymerized gasoline.

Western Precipitation Co., Los Angeles, has organized the Precipitation Company of Canada, Ltd., with offices at 1010 St. Catherine St., West, Montreal.

Parker Appliance Co., Cleveland, is now occupying larger quarters at 17325 Euclid Ave.

Atlas Powder Co., Wilmington, Del., announces that its subsidiaries, the Zapon Co. and the Zapon Brevolite Lacquer Co., manufacturers of coated fabrics and industrial finishes, have become divisions of Atlas Powder Co. There will be no change in management, personnel or policies under the new set-up.

# New CONSTRUCTION

### Where Plants Are Being Built in Process Industries

| | Current Projects | | Cumulative 1935 | |
|---|---|---|---|---|
| | Proposed Work | Contracts | Proposed Work | Contracts |
| New England.......... | $209,000 | $58,000 | $964,000 | $456,000 |
| Middle Atlantic........ | 70,000 | 105,000 | 3,288,000 | 3,675,000 |
| South................ | 56,000 | 98,000 | 12,216,000 | 6,139,000 |
| Middle West.......... | 1,085,000 | 264,000 | 12,360,000 | 10,726,000 |
| West of Mississippi..... | 80,000 | 119,000 | 7,273,000 | 7,271,000 |
| Far West.............. | 28,000 | 150,000 | 3,977,000 | 6,388,000 |
| Canada............... | 1,268,000 | ........ | 13,251,000 | 1,778,000 |
| Total............... | $2,796,000 | $794,000 | $53,329,000 | $36, 433,000 |

## PROPOSED WORK
## BIDS ASKED

**Brick Plant**—White-Washburne Co., Inc., Main St., Hinsdale, N. H., is having preliminary plans prepared by McClintock & Craig, Archts., 458 Bridge St., Springfield, Mass., for the construction of a brick manufacturing plant. Estimated cost $80,000.

**Carbon Black Plant** — United Carbon Co., Charleston, W. Va., contemplates the construction of a carbon black plant at Moore, Tex. Estimated cost $30,000.

**Coking Plant**—Grant Engineering Co., 1164 Beaver Hall Sq., Montreal, Que., Can., plans the construction of a coking plant 3 mi. east of Kitchener, Ont., to process bituminous coal and lignite into a patent fuel with a by-product of gasoline. Maturity in Spring, 1936. Estimated cost $800,000.

**Distillery**—Oldetyme Distillers Co., 122 East 42nd St., New York, N. Y., has acquired the plant at Lackawanna Terminal, Jersey City, N. J., formerly occupied by Hiram Walker & Sons and will improve bottling and distribution facilities. Estimated cost including machinery and equipment, $40,000.

**Distillery**—Schenley Corp., 20 West 40th St., New York, N. Y., contemplates the construction of a 4 story addition to its distillery at Lawrenceburg, Ind. Carl J. Kiefer, Schmidt Bldg., Cincinnati, O., Archt. and Engr. Estimated cost $800,000.

**Gas Plant**—City, Mt. Vernon, Ind., is having plans prepared by D. T. Blakey, Engr., 22 N. W. 2nd St., Evansville, Ind., for the construction of a gas manufacturing and storage plant. Estimated cost $60,000.

**Gas Plant** — Wisconsin Power & Light Co., 122 West Washington St., Madison, Wis., plans to construct an addition to its gas plant at Fond du Lac, Wis. Estimated cost $150,000.

**Gasoline Plant**—British American Oil Co., c/o L. E. Wooley, Royal Bank Bldg., Toronto, Ont., Can., will soon award the contract for the construction of an absorption unit at its gasoline plant at South Turner Valley in the vicinity of Calgary, Alta. Estimated cost $300,000.

**Laboratory** — American Rolling Mill Co., Middletown, O., plans to construct a 3 story laboratory and office building to replace the one destroyed by fire and explosion. Estimated cost $75,000.

**Oil Refinery**—Goose Lake Oil Refining Co., Ltd., Kindersley, Sask., Can., plans to construct an oil refinery. Estimated cost $50,000.

**Oil Refinery**—Naph-Sol Refining Co., Muskegon, Mich., plans to alter its refinery here. Estimated cost $40,000.

**Laboratory**—R. T. Vanderbilt Co., East Norwalk, Conn., will construct an addition to its laboratory. H. T. Lindeberg, 2 West 47th St., New York, Archt. Estimated cost exceeds $28,500.

**Paint Factory**—Bapco Paint Co., Ltd., Victoria, B. C., J. C. Pendray, Mgr., plans to construct a factory at Calgary, Alta.

**Paper Mill** — Cheshire Paper Co., Hinsdale, N. H., H. S. Garfield, Vice Pres., is having plans prepared by McClintock & Craig, Archts., 458 Bridge St., Springfield, Mass., for rebuilding its paper mill on Main St., recently destroyed by fire. Estimated cost will exceed $100,000.

**Paper Mill**—Grays Harbor Pulp & Paper Co., Hoquiam, Wash., W. S. Lucey, Mgr., plans to construct a break-down and clipping plant.

**Paper Manufacturing Machinery**—Hinsdale Paper Mfg. Co., Hinsdale, N. H., L. D. Stearns, Treas., plans to replace paper manufacturing machinery recently damaged by fire.

**Plant**—Southern Naval Stores Co., Columbia, Miss., plans to construct a plant to extract turpentine and pitch from stumps in Marion Co. Estimated cost including equipment $28,000.

**Refractories Plant**—Mexico Refractories Co., Mexico, Mo., plans to improve its plant here. Estimated cost $50,000.

**Shellac Plant**—Southern Shellac Mfg. Co., 556 Suzette St., Memphis, Tenn., plans to construct an addition to its plant. Estimated cost including equipment $28,000.

**Stearic Acid Plant**—Wilson-Martin Co., Water St. and Snyder Ave., South Philadelphia, Pa., plans to repair and alter its stearic acid plant. Estimated cost $30,000.

**Sugar Factory** — Canadian Sugar Factories, Ltd., Lethbridge, Alta., Can., plans the construction of 6 concrete bins, each 25 ft. high, having a capacity of 25,000,000 lbs. of refined sugar at their Picture Butte factory.

**Tannery**—Guilbert Fur Co., Ltd., St. Pie de Bagot, Que., Can., plans to rebuild its 3 story tannery recently destroyed by fire with a loss of $50,000.

## CONTRACTS AWARDED

**Cement Plant**—Lehigh Portland Cement Co., Fordwick, Va., will build an addition to its cement plant. Separate contracts have been awarded. Structural steel contract has been let to Roanoke Bridge & Iron Works, Roanoke, Va. Estimated cost $30,000.

**Chemical Plant**—Mutual Chemical Co. of America, Block and Willis Sts., Baltimore, Md., awarded contract for an addition to its plant to Maryland Metal Building Co., Race and McComas Sts., Baltimore. Estimated cost $40,000.

**Clay Factory**—Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., will construct a clay plant at Biron, Wis. Structural steel contract has been let to Wisconsin Bridge & Iron Co., 5023 North 35th St., Milwaukee; reinforcing steel to Concrete Steel Co., 176 West Wisconsin Ave., Milwaukee.

**Factory** — Corning Glass Works, Corning, N. Y., J. Romig, Gen. Mgr., Fibre Products Division, will construct a 2 story, 80x240 ft. factory for the manufacture of glass wool, also a 36x48 ft. boiler house, on **East Tioga St.** Work will be done by own forces under supervision of Alfred Vaksdal, Engr., c/o Company.

**Factory**—Matchless Metal Polish Co., 840 West 90th Pl., Chicago, Ill., awarded contract for addition to factory to A. T. Herlin, 6816 Clyde Ave., Chicago. Estimated cost $40,000.

**Factory**—Musterole Co. (medicinal supplies), 1748 East 27th St., Cleveland, O., G. H. Miller, Secy., has awarded the contract for an addition to its factory to S. W. Emerson Co., 1836 Euclid Ave., Cleveland. Estimated cost $40,000.

**Factory**—The United States Stoneware Co., Akron, O., manufacturer of corrosion-proof equipment, is building a machine shop and metal fabrication building to take care of the growing demand for corrosion-proof pumps, fans and exhausters, etching machines, power mixing units, jar mills, etc.; a new clay fabrication building; clay storage and processing department building; power plant building, at their Tallmadge, O., works.

**Furnace Building** — National Carbon Co., West 117th St. and Madison Ave., Cleveland, O., has awarded the contract for the construction of a 1 story furnace building to Gillmore-Carmichael-Olson Co., 1873 East 55th St., Cleveland. Estimated cost $50,000.

**Laboratory**—Institute of Paper Chemistry, Appleton, Wis., has awarded the contract for the construction of a 2 story, 40x115 ft. and 42x35 ft. laboratory to B. B. Ganther Co., Oshkosh, Wis.

**Laboratory** — Swann & Co., Brown Marx Bldg., Birmingham, Ala. (organic chemicals), will construct a laboratory, storage and office building at 2nd Ave. and 32nd St., Birmingham. Separate contracts have been awarded for the work. Estimated cost to exceed $28,000.

**Laboratory**—Treasury Dept., Procurement Division, Washington, D. C., awarded contract for three new buildings at Public Health Service's Rocky Mountain Laboratory at Hamilton, Mont., to Smythe & Co., 1416 F St., N. W., Washington, D. C. $119,342.

**Linseed Oil Factory**—Spencer-Kellogg & Sons, Niagara Sq., Buffalo, N. Y., have acquired a six acre site on Cerritos Ave. Channel, Long Beach, Calif., and will construct a mill building, refinery, boiler house, office building, warehouse, grain elevator and wharf. Work will be done by day labor under supervision of W. J. Moran, Engr., 1011 South Fermont St., Alhambra. Estimated cost $150,000.

**Rubber Factory**—Gillette Rubber Co., Eau Claire, Wis., has awarded the contract for a 2 story addition to its factory to Hoeppner-Bartlett Co., Eau Claire.

**Rubber Factory**—Hodgman Rubber Co., Herbert St., Framingham, Mass., has awarded the contract for the construction of Building No. 8 to J. J. Convisor, 333 Washington St., Boston. Estimated cost exceeds $28,500.

**Sugar Factory**—Henderson Sugar Co., 749 South Peters St., New Orleans, La., awarded contract for addition to factory to Perrilliat Rickey Constr. Co., Eureka Bldg., New Orleans. Estimated cost $40,000.

**Warehouse**—Dewey & Almy Chemical Co., 235 Harvey St., Cambridge, Mass., awarded contract for addition to warehouse to L. C. Blake Constr. Co., 50 Dyer Ave., Milton, Mass. Estimated cost will exceed $28,500.

**Warehouse** — Defiance Paper Co., Walnut Ave. and 3rd St., Niagara Falls, N. Y., awarded contract for additions and alterations to warehouse to Wright & Kremers, Inc., Main and Pine Aves., Niagara Falls.

## CHANGES IN SEASONAL TRENDS FOR DISTRIBUTION OF PAINT

RECENT RELEASE of figures covering the sale of paints, varnish, and lacquers reveal that such sales for last November reached a total of $25,606,631 compared with a value of $19,801,013 as reported for November, 1934. Total sales for last November, in fact were the largest for that month during the years since 1929.

A review of sales in the pre-depression years brings out the fact that the peak of sales generally is reached in the month of May and this has held pretty much true for all the years to date for which sales data are available. This monthly review also establishes that the low level of sales was reached in the months of November and December. In 1935 the value of sales as reported for November was in excess of that reported for January and February and was not far below that given for March. This may mark the beginning of a trend away from the customary seasonal movement and may presage a more evenly distributed sale of paint, varnish, and lacquer over the 12 months of the year.

Naturally, weather conditions must continue to be an influential factor and the greater part of outdoor painting will be done in the spring and fall months as has been the case in the past. This in itself is guarantee sufficient to dispel belief in the theory that any decided changes in the seasonal trends for consumption of paints is to be encountered.

However, the manner in which the use of paints was speeded up—even in the last quarter of the year—for residential building and for renovating homes under the Federal Housing Act illustrates the possibility of a 12-month painting program.

The moving forward of automotive production schedules also offers an illustration of what may take place in the way of changing trends in the way of industrial consumption of paint.

The paint trade entered the new year in such favorable condition that a new record for production and sales seems almost assured. Gains made in 1935 are expected to continue through the current year with a much higher rate of gain. In some quarters it is held that the 1935 total will be almost tripled in 1936. One report says that while the distribution of household paints was accelerated by the revival of residential building and renovizing, which was stimulated by modernization credit loans and the mutual mortgage insurance plan of the F. H. A., much of the expansion in the general industrial division was contributed by automobile manufacturers, whose purchases were larger by nearly 60 per cent than a year ago. In the furniture, electric refrigerator, and household goods division, there was a steady widening of consumption, with generous commitments for spring delivery already placed.

The paint and chemical industries will occupy a double role as major sources and beneficiaries of a 50 per cent increase in industrial building in prospect for 1936, according to George A. Bryant, Jr., executive vice president of The Austin Co., national organization of industrial engineers and builders.

"The increasing use and number of synthetic products to replace natural materials in manufacturing operations has produced a substantial demand for new plant facilities in the chemical and allied industries," Mr. Bryant said.

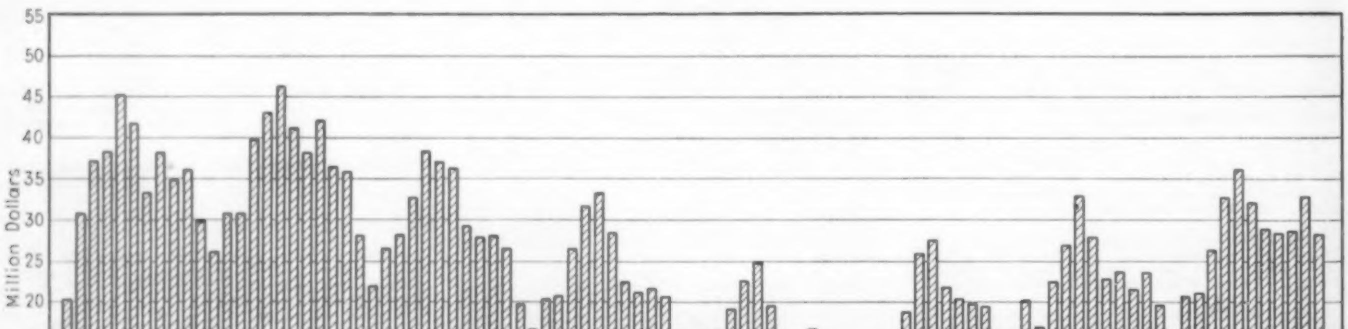
"High workability and wearing qualities have won widespread acceptance of new materials. They in turn have expanded the basic demands upon the chemical industry and place it in a unique position to benefit by expected increases in all manufacturing lines in 1936, as well as from construction of facilities to keep up with this volume.

"The extent to which individual producers of chemicals, paints and kindred products will share in the profits now in prospect depends upon the extent to which their facilities have been adapted to changed competitive conditions which are throwing an entirely new emphasis upon price.

"Manufacturers generally have come to realize that all non-essential operating and distribution costs not only impede corporate gains but limit the ultimate volume of demand by erecting price barriers that consumers cannot or will not hurdle. This realization has prompted far-sighted executives to abandon plants and equipment still good for years of service, when they see that these assets only perpetuate excessive costs.

"New plants erected in their stead have the advantages of strategic location with respect to raw materials, markets and labor. They have a flexibility which permits profitable operations while running at fractional capacity and can be adapted to any given volume or change of business with minimum expense. Beyond this, comlpete control of physical as well as mechanical conditions inside the plants affords a basis of harmony and efficiency among employees which is difficult to maintain in older, high cost structures."

**Monthly Sales of Paint, Varnish and Lacquer Products, 1928-1935**



# STEPS IN THE DEVE

# NEW PRODUCTS


**EXPLANATION**

Not every industrial organization is equipped to follow this exact sequence of successive steps but, with certain qualifications noted below, this chart and the accompanying check-lists offer a reliable guide in new-product development. The value of the answers to this group of basic questions depends wholly on: (1) The thoroughness with which every man in the organization studies not only those questions checked for his direct responsibility but also all others that in any way overlap or qualify them. (2) The extent to which all answers are free from prejudice. (3) The consistency with which the policy of the company follows the road pointed out by these facts.


**CHEMICAL & METALLURGICAL ENGINEERING**
*Editorial Supplement to Vol. 43, No. 2, February, 1936.*




## Check-Lists of Questions to

# PRODUCTION

## RESEARCH AND ENGINEERING DEVELOPMENT

| | BOARD OF DIRECTORS | PRESIDENT AND GENERAL EXECUTIVES | TREASURER AND COMPTROLLER | CHIEF PRODUCTION EXECUTIVE | (a) Plant superintendent | (b) Plant engineers | (c) Control laboratory | CHIEF RESEARCH EXECUTIVE | (a) Research chemists and engineers | (b) Development engin | CHIEF ENGIN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I. SOURCES OF IDEAS FOR NEW PRODUCTS | X | X | X | X | X | X | X | X | X | X | X |
| Has each of the following sources been fully and continuously developed: | | | | | | | | | | | |
| (a) Research and development staffs? | | X | | | | | | X | X | X | |
| (b) Production and operating staffs? | | | | | | | | | | | |

# VELOPMENT AND INTRODUCTION O

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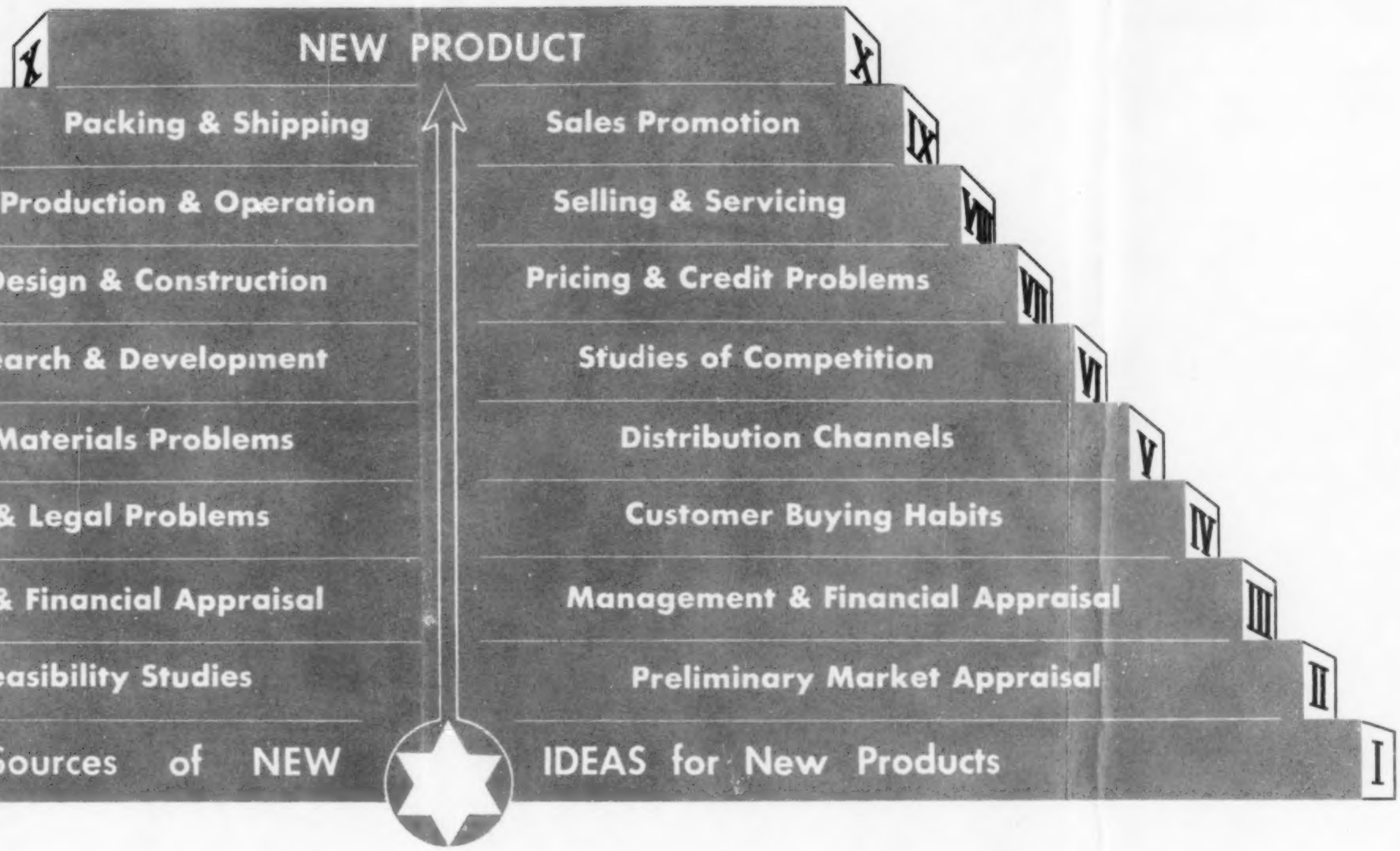


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## to Be Answered at Each Step in New-Product Development

| ...ers | (c) Control laboratory | CHIEF RESEARCH EXECUTIVE | (a) Research chemists and engineers | (b) Development engineers | CHIEF ENGINEER | (a) Design engineers | (b) Construction engineers | CHIEF SALES EXECUTIVE | (a) Sales staff | (b) Sales service engineers | (c) Sales development engineers | (d) Sales promotion managers | PACKAGING AND TRAFFIC DEPARTMENT | PATENT AND LEGAL DEPARTMENT | PURCHASING AGENT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| | | | | | | | | | | | | | | | |
| X | X | X | | | | | | | | | | | | | |

# MARKETING

## SALES DEVELOPMENT AND ORGANIZATION

| | BOARD |
|---|---|
| I. SOURCES OF IDEAS FOR NEW PRODUCTS | X |
| Has each of the following sources been fully and continuously developed: | |
| (a) Sales development and promotion staffs? | |
| (b) Sales and customer service staffs? | |
| (c) Wholesale and retail distributors? | |

(b) Production and operating staffs?

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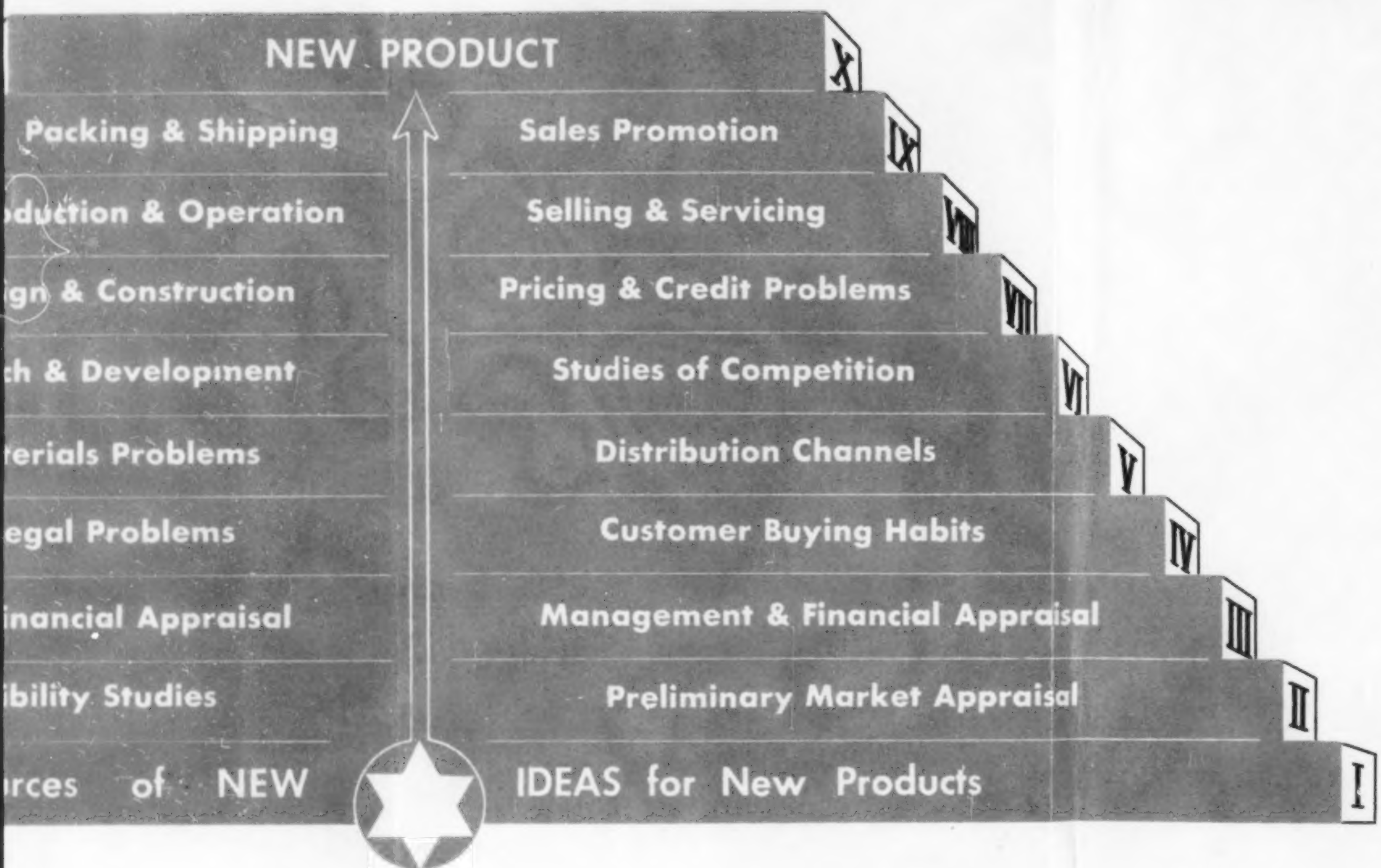


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## ...o Be Answered at Each Step in New-Product Development

...EXECUTIVE
(a) Research chemists and engineers
(b) Development engineers
CHIEF ENGINEER
(a) Design engineers
(b) Construction engineers
CHIEF SALES EXECUTIVE
(a) Sales staff
(b) Sales service engineers
(c) Sales development engineers
(d) Sales promotion managers
PACKAGING AND TRAFFIC DEPARTMENT
PATENT AND LEGAL DEPARTMENT
PURCHASING AGENT

# MARKETING

## SALES DEVELOPMENT AND ORGANIZATION

BOARD OF DIRECTORS
PRESIDENT AND GENERA...
TREASURE...

I. SOURCES OF IDEAS FOR NEW PRODUCTS

Has each of the following sources been fully and continuously developed:

(a) Sales development and promotion staffs?

(b) Sales and customer service staffs?

# OF

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**ACKNOWLEDGMENT**

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## nt

| BOARD OF DIRECTORS | PRESIDENT AND GENERAL EXECUTIVES | TREASURER AND COMPTROLLER | CHIEF PRODUCTION EXECUTIVE | (a) Plant superintendent | (b) Plant engineers | (c) Control laboratory | CHIEF RESEARCH EXECUTIVE | (a) Research chemists and engineers | (b) Development engineers | CHIEF ENGINEER | (a) Design engineers | (b) Construction engineers | CHIEF SALES EXECUTIVE | (a) Sales staff | (b) Sales service engineers | (c) Sales development engineers | (d) Sales promotion managers | PACKAGING AND TRAFFIC DEPARTMENT | PATENT AND LEGAL DEPARTMENT | PURCHASING AGENT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | X | X | X | X | X | | | |
| | | | | | | | | | | | | | X | X | X | X | X | | | |

Management & Financial Approval

| | BOARD O… | PRESIDEN… | TREASURE… | CHIEF PR… | (a) P… |
|---|---|---|---|---|---|
| **I. SOURCES OF IDEAS FOR NEW PRODUCTS** | X | X | X | X | X |
| Has each of the following sources been fully and continuously developed: | | | | | |
| (a) Research and development staffs? | | X | | | |
| (b) Production and operating staffs? | | X | | X | X |
| (c) Independent inventors? | | X | | X | |
| (d) Research and engineering consultants? | | X | | X | |
| (e) Competitor's activities? | | X | | X | |
| (f) Non-competitive activities of other companies? | | X | | X | |
| (g) Scientific and technical societies? | | | | X | X |
| (h) Technical and trade literature? | | X | | X | X |
| **II. PRELIMINARY FEASIBILITY STUDIES** | | | | | |
| 1. Is there any engineering or production reason why the new product should not be considered? | | X | | X | X |
| 2. Is there any reason, from sales, management or company viewpoints against its consideration? | X | X | X | | |
| 3. Is the proposed process likely to prove practicable? | | X | | X | |
| 4. If not, are there other processes to be considered? | | X | | X | |
| 5. What additional laboratory research would be required? What would it cost? | | X | X | | |
| 6. What prospective process development is necessary? Cost? | | X | X | X | |
| 7. Would any unusual production problems be involved? | | | | X | X |
| (a) To obtain desired quality? | | | | X | X |
| (b) To promote safety? | | | | X | X |
| (c) To correlate with present products? | | | | X | X |
| 8. Are any unusual legal or patent problems likely to be involved? | | X | | | |
| 9. Are raw materials readily available? | | X | | | |
| 10. What are the best preliminary estimates of | | | | | |
| (a) Maximum and minimum production costs? | | X | X | X | X |
| (b) Maximum and minimum distribution costs? | | X | X | | |
| (c) Maximum and minimum profit margins? | | X | X | X | |
| **III. MANAGEMENT AND FINANCIAL APPRAISAL—PRELIMINARY AND FINAL** | | | | | |
| Note: Managerial and financial problems are involved at every step in the entire development. Hence many of the questions below can only be answered AFTER subsequent problems have been solved. | | | | | |
| 1. Which of the following purposes will be served by this new product? | | | | | |
| (a) Complete company's present line of products? | | X | X | X | X |
| (b) Fill gap in existing market? | | X | | | |
| (c) Round out present seasonal markets? | | X | | | |
| (d) Expand sales in present markets? | | X | | | |
| (e) Do better job than present products? | | X | | | |
| (f) Anticipate changing consumer needs? | | X | | | |
| (g) Enter a new market? | | X | | | |
| (h) Fill idle time of plant or equipment? | | X | | X | X |
| (i) Substitute for products of declining demand? | | X | X | X | |
| (j) Increase reputation of manufacturer? | X | X | X | | |
| (k) Stimulate attention to company by new customers? | | X | | | |
| 2. Before project is finally approved, the following financial questions must be answered: | | | | | |
| (a) Is new capital required? | X | X | X | | |
| (b) If so, will its cost be reasonable? | X | X | X | | |
| (c) Has adequate anticipated balance sheet been prepared? | | X | | X | |
| (d) Does expected sales realization show adequate profit margin? | | X | X | | |
| (e) Can rapid depreciation and obsolescence items be allowed? | | X | X | X | X |
| (f) Does new product plan fit general financial program of company? | X | X | X | | |
| (g) Will new plans be unduly burdensome on management? | | X | X | | |
| (h) What is prospective stockholder attitude? | X | X | X | | |
| (i) Does prospective profit warrant risk under most adverse circumstances anticipated? | X | X | X | X | |
| **IV. LEGAL AND PATENT PROBLEMS—PRELIMINARY AND FINAL** | | | | | |
| 1. Do trade or company agreements interfere with proposed plans? | | X | X | | |
| 2. Do any local, state, or national laws preclude proposed designs or operating plans? | | X | X | | |
| 3. Is sales of product legally unrestricted in all markets to be reached? | | X | | | |
| 4. Can needed new laws be secured with reasonable promptness? | | X | | | |
| 5. Have all label, marketing, and merchandising laws been considered? | | X | | | |
| 6. Are patent rights of company adequate to prevent infringement suits? | | X | | | |
| 7. What patent protection does company have to prevent competition? | | X | | | |
| 8. What new patents could be obtained by company; by competitors? | | X | | | |
| 9. Can proposed customers legally use product as contemplated? | | X | | | |
| 10. What public safety precautions are needed in merchandising or ultimate customer use? | | X | | | |
| 11. Have industrial safety and workmen's compensation laws been adequately considered? | | X | | X | X |
| **V. RAW MATERIAL PROBLEMS** | | | | | |
| 1. What new materials are required? | | X | | | |
| 2. Are adequate supplies assured, and for how long? | | X | | | |
| 3. Are sources of raw material dependable? | | X | | | |
| 4. Prospective geographic source or delivery point? | | | | | |
| 5. What raw materials inventory must be maintained? | | | | X | X |
| 6. What substitutes can be used if raw material supply is interrupted? | | | | | |
| 7. What will effect of substitution be on cost? On quality of product? | | | X | X | X |
| 8. Can tariff changes affect raw material supply or cost? | | X | X | | |
| 9. Do prospective competitors control part of raw material supply? Or can company gain monopoly? | | X | X | | |
| 10. What transportation problems or costs affect raw material price at processing plant? | | X | X | | |
| 11. What special storage facilities will be required? | | X | | X | X |
| **VI. RESEARCH AND DEVELOPMENT** | | | | | |
| 1. Is process flowsheet for new product established? | | X | | | |
| 2. How long will completion of general process flowsheet require? | | X | | | |
| 3. What experimental laboratory research is needed: | | | | | |
| (a) To determine yields? Cost? | | X | | X | X |
| (b) [illegible] Cost? | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

## I. SOURCES OF IDEAS FOR NEW PRODUCTS

Has each of the following sources been fully and continuously developed:

(a) Sales development and promotion staffs?
(b) Sales and customer service staffs?
(c) Wholesale and retail distributors?
(d) Marketing and other consultants?
(e) Competitor's activities?
(f) Non-competitive activities of other companies?
(g) Trade association activities?
(h) Trade literature of consuming industries?

## II. PRELIMINARY MARKET APPRAISAL

1. What industries will use the new product?
2. How large is each consuming industry?
3. How much of the new product will each use?
4. Where and what are these industries now buying?
5. Where are these consuming industries located?
   (a) Are they localized in certain areas?
   (b) Are they widely distributed geographically?
6. Which industries show positive growth projection?
7. Which industries show negative growth projection?
8. What is best estimate of potential market?

## III. MANAGEMENT AND FINANCIAL APPRAISAL—PRELIMINARY AND FINAL

Note: Managerial and financial problems are involved at every step in the entire developmen[t]. Hence many of the questions below can only be answered AFTER subsequent problems have been solved.

1. Is ownership of new product established?
2. Is it adequately protected by trade-mark?
3. Is its manufacture adequately protected by patents?
4. Do latter infringe any existing patents?
5. Are all claims to royalties or other indemnities provided for?
6. Do any agreements limit size of market?
7. Do any agreements limit sales or advertising effort?
8. Have all transportation problems and transportation costs been foreseen?
9. What are estimated local, state and federal taxes?
10. What are local, state and national laws covering manufacturing?
11. Has legal department made adequate study of
    (a) Employee compensation?
    (b) Possible damage suits against manufacturer?
    (c) Labor and sanitary laws?
12. To what extent do any or all of these affect:
    (a) Cost of manufacture?
    (b) Cost of selling?
    (c) Cost to consumer?

## IV. CUSTOMERS' BUYING HABITS

1. Who in customer organization places order for new product?
2. Does he buy on his own judgment or upon recommendation of others?
3. Who else are involved in the buying decision?
4. Should each of these be called on?
5. What relative weight will the purchasing group give to
   (a) Price factors?
   (b) Quality of product?
   (c) Safety in storage and handling?
   (d) Service rendered by manufacturer?
   (e) Dependability of source of supply?
6. Does location of present source of supply offer competitive advantage?
7. Is the market for new product subject to seasonal fluctuations?
8. What are the market practices on discount allowances, credits, etc.?

## V. DISTRIBUTION CHANNELS

1. Is the market for new product subject to wide fluctuation?
2. Is any part of the fluctuation regional?
3. Is any part of the market stable in its demands?
4. Is the stable market regional or national?
5. What type of distribution organization will be used?
   (a) Manufacturers—sales branches?
   (b) Manufacturers—regional sales forces?
   (c) Home office sales force selling to all consumers?
   (d) Wholesalers and jobbers?
   (e) Manufacturers' agents?
   (f) Combinations of above?
6. Will the new product go into the export field?
7. How will sales abroad be handled?
8. Will any channel of distribution be new to the company?
9. Will selling methods fit buying habits of the market?
10. Will selling methods fit into company's sales organization?

## VI. STUDIES OF COMPETITION

1. Who will be your competitors on new product?
2. What is the standing of each in the market?
3. What is the reputation of each for
   (a) Quality of product?
   (b) Market dominance?
   (c) Character of merchandise?
   (d) Dependability?
   (e) Service?

4. Will new product invite keener competition on present lines?

(a) To determine yields? Cost?

I. SOURCES OF IDEAS FOR NEW PRO

Has each of the following sources be

(a) Sales development and prom

(b) Sales and customer service s

(c) Wholesale and retail distrib

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   (d) Dependability?
   (e) Service?
   (f) Progressiveness?

9. Can proposed customers legally use product as contemplated
10. What public safety precautions are needed in merchandising or ultimate customer use?
11. Have industrial safety and workmen's compensation laws been adequately considered?

V. RAW MATERIAL PROBLEMS

4. Will new product invite keener competition on present lines?

| | BOA | PRE | TRE | CHI | | | | CHI | | | CHI | | | CHE | | | | | PA | PA | PU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **R NEW PRODUCTS** | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **g sources been fully and continuously developed:** | | | | | | | | | | | | | | | | | | | | | |
| **nt and promotion staffs?** | | | | | | | | | | | | | | X | X | X | X | X | | | |
| **ner service staffs?** | | | | | | | | | | | | | | X | X | X | X | X | | | |
| **retail distributors?** | | | | | | | | | | | | | | X | X | X | X | | | | |
| **other consultants?** | | X | | | | | | X | | | | | | X | | | | | | | |
| **ivities?** | | X | | | | | | X | | | | | | X | X | X | X | X | | | |
| **activities of other companies?** | | X | | | | | | X | | | | | | X | | X | X | X | | | |
| **n activities?** | | X | | | | | | X | | | | | | X | X | X | X | X | X | | |
| **of consuming industries?** | | | | | | | | X | X | | | | | X | X | X | X | X | X | | |
| **APPRAISAL** | | | | | | | | X | X | | | | | X | X | X | X | X | P | | |
| **use the new product?** | | | | | | | | | | | | | | X | X | X | X | | | | |
| **nsuming industry?** | | | | | | | | | | | | | | X | X | X | X | | | | |
| **ew product will each use?** | | | | | | | | X | X | | | | | X | X | X | X | X | | | |
| **these industries now buying?** | | | | | | | | | | | | | | X | X | X | X | X | | | |
| **nsuming industries located?** | | | | | | | | | | | | | | X | X | X | X | X | T | | |
| **ed in certain areas?** | | | | | | | | | | | | | | X | X | X | X | X | T | | |
| **distributed geographically?** | | | | | | | | | | | | | | X | X | X | X | X | T | | |
| **w positive growth projection?** | | | | | | | | | | | | | | X | | | X | | | | |
| **ow negative growth projection?** | | | | | | | | | | | | | | X | | | X | | | | |
| **te of potential market?** | | X | | | | | | X | X | | | | | X | | | X | | | | |
| **FINANCIAL APPRAISAL—PRELIMINARY AND FINAL** | | | | | | | | | | | | | | | | | | | | | |
| financial problems are involved at every step in the entire development. | | | | | | | | | | | | | | | | | | | | | |
| ions below can only be answered AFTER subsequent problems have been solved. | | | | | | | | | | | | | | | | | | | | | |
| **product established?** | | X | X | | | | | X | | | | | | X | | | X | | | L | |
| **ected by trade-mark?** | | X | | | | | | | | | | | | X | | | | | | P | |
| **dequately protected by patents?** | | | | | | | | X | X | X | X | | | | | | | | | P | |
| **y existing patents?** | | | | | | | | X | X | X | X | | | | | | | | | P | |
| **lties or other indemnities provided for?** | | | | | | | | X | | | | | | X | | | X | | | L | |
| **mit size of market?** | | X | X | | | | | | | | | | | X | | | X | | | L | |
| **imit sales or advertising effort?** | | X | X | | | | | | | | | | | X | X | X | X | X | P | L | |
| **on problems and transportation costs been foreseen?** | | | | | | | | X | X | | | | | X | | | X | | T | | |
| **local, state and federal taxes?** | | X | X | | | | | X | | | | | | X | | | | | | L | |
| **and national laws covering manufacturing?** | | X | | X | X | | | X | | X | | | | | | | | | | L | |
| **made adequate study of** | | X | | | | | | | | | | | | | | | | | | L | |
| **ensation?** | | X | | X | X | | | | | | | | | | | | | | | L | |
| **suits against manufacturer?** | | X | | X | X | | | X | | | | | | | | | | | | L | |
| **ry laws?** | | X | | X | X | | | | | | | | | | | | | | | L | |
| **ny or all of these affect:** | | | | | | | | | | | | | | | | | | | | | |
| **cture?** | | X | X | X | X | X | | X | X | X | X | | | | | | | | | L | |
| | | X | X | | | | | | | | | | | X | X | X | X | | X | L | |
| **er?** | | X | X | | | | | | | | | | | X | X | X | X | | X | L | |
| **HABITS** | | | | | | | | | | | | | | | | | | | | | |
| **anization places order for new product?** | | | | | | | | | | | | | | X | X | X | X | X | | | X |
| **own judgment or upon recommendation of others?** | | | | | | | | | | | | | | X | X | X | X | X | | | X |
| **d in the buying decision?** | | | | | | | | | | | | | | X | X | X | X | X | | | X |
| **be called on?** | | | | | | | | | | | | | | X | X | | X | | | | |
| **t will the purchasing group give to** | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | X | X | | X | | | | X |
| **ct?** | | | | | | | X | X | X | | | | | | | | X | | | | X |
| **e and handling?** | | | | X | X | | | X | X | | | | | X | | | X | | P | | X |
| **by manufacturer?** | | | | | | | | X | | | | | | X | X | X | X | | | | X |
| **f source of supply?** | | | | | | | | | | | | | | X | X | X | X | X | | | X |
| **esent source of supply offer competitive advantage?** | | X | | | | | | | | | | | | X | X | X | X | | T | | X |
| **ew product subject to seasonal fluctuations?** | | X | | | | | | X | | | | | | X | | | X | | | | X |
| **et practices on discount allowances, credits, etc.?** | | X | X | | | | | | | | | | | X | | | X | | | | X |
| **IELS** | | | | | | | | | | | | | | | | | | | | | |
| **w product subject to wide fluctuation?** | | | | | | | | | | | | | | X | | | X | | | | X |
| **luctuation regional?** | | | | | | | | | | | | | | X | | | X | | | | X |
| **arket stable in its demands?** | | | | | | | | | | | | | | X | | | X | | | | X |
| **regional or national?** | | | | | | | | | | | | | | X | | | X | | T | | X |
| **ution organization will be used?** | | X | X | | | | | | | | | | | X | X | X | X | | | | X |
| **—sales branches?** | | X | X | | | | | | | | | | | X | | | X | | | | |
| **—regional sales forces?** | | X | X | | | | | | | | | | | X | | | X | | | | |
| **les force selling to all consumers?** | | X | X | | | | | | | | | | | X | | | X | | | | |
| **d jobbers?** | | X | X | | | | | | | | | | | X | | | X | | | | |
| **agents?** | | X | X | | | | | | | | | | | X | | | X | | | | |
| **f above?** | | X | X | | | | | | | | | | | X | | | X | | | | |
| **ct go into the export field?** | | X | X | | | | | | | | | | | X | X | X | X | X | X | | |
| **d be handled?** | | X | X | | | | | | | | | | | X | X | X | X | X | X | | |
| **distribution be new to the company?** | | X | X | | | | | | | | | | | X | X | X | X | X | X | | |
| **ds fit buying habits of the market?** | | X | X | | | | | | | | | | | X | X | X | X | X | X | | |
| **s fit into company's sales organization?** | | X | X | | | | | | | | | | | X | X | X | X | X | X | | |
| **ITION** | | | | | | | | | | | | | | | | | | | | | |
| **competitors on new product?** | | X | X | | | | | X | X | | | | | X | X | X | X | / | | | X |
| **ng of each in the market?** | | X | X | | | | | X | | | | | | X | X | X | X | X | | | X |
| **tion of each for** | | | | | | | | | | | | | | | | | | | | | |
| **duct?** | | | | | | | X | X | X | | | | | X | X | X | X | X | | | X |
| **ance?** | | | | | | | | | | | | | | X | X | X | X | X | | | X |
| **erchandise?** | | | | | | | X | X | X | | | | | X | X | X | X | X | | | X |
| | | | | | | | | | | | | | | X | X | X | X | X | | | X |
| | | | | | | | | | | | | | | X | X | X | X | X | | | X |
| **?** | | | | | | | | X | | | | | | X | X | X | X | X | | | X |

(c) Home office sales force selling to all consumers?

(d) Wholesalers and jobbers?

(e) Manufacturers' agents?

(f) Combination of above?

(f) Progressiveness?

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 9. Can proposed customers legally use product as contemplated? | | X | | | | | | X |
| 10. What public safety precautions are needed in merchandising or ultimate customer use? | | X | | X | X | X | | X |
| 11. Have industrial safety and workmen's compensation laws been adequately considered? | | | | | | | | |
| **V. RAW MATERIAL PROBLEMS** | | | | | | | | |
| 1. What new materials are required? | | X | | | | | | X |
| 2. Are adequate supplies assured, and for how long? | | X | | | | | | X |
| 3. Are sources of raw material dependable? | | X | | | | | | X |
| 4. Prospective geographic source or delivery point? | | | | | | | | X |
| 5. What raw materials inventory must be maintained? | | | | X | X | | | X |
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| 7. What will effect of substitution be on cost? On quality of product? | | | X | X | X | | | X |
| 8. Can tariff changes affect raw material supply or cost? | | X | X | | | | | X |
| 9. Do prospective competitors control part of raw material supply? Or can company gain monopoly? | | X | X | | | | | X |
| 10. What transportation problems or costs affect raw material price at processing plant? | | X | X | | | | | X |
| 11. What special storage facilities will be required? | | X | | X | X | | | X |
| **VI. RESEARCH AND DEVELOPMENT** | | | | | | | | |
| 1. Is process flowsheet for new product established? | | X | | | | | | X |
| 2. How long will completion of general process flowsheet require? | | X | | | | | | X |
| 3. What experimental laboratory research is needed: | | | | | | | | |
| (a) To determine yields? Cost? | | X | | X | X | X | | X |
| (b) To improve processes? Cost? | | X | | X | X | X | | X |
| 4. Can standard unit equipment be used? | | | | X | X | X | | X |
| 5. Are designs for new or modified unit equipment available? | | | | X | | | | X |
| 6. Will new materials for equipment construction be necessary? | | | | X | | | | X |
| 7. Can equipment constructed of requisite materials be quickly had; at what cost? | | | | X | | | | X |
| 8. Do present small-scale tests ensure large scale operation? | | | | X | X | X | | X |
| 9. What unusual plant design problems are expected? | | | | X | X | X | | X |
| 10. What special employee safety precautions are needed? | | | | X | X | X | | X |
| 11. Are unusual depreciation and obsolescence factors anticipated? | | X | X | X | X | | | X |
| **VII. DESIGN AND CONSTRUCTION** | | | | | | | | |
| 1. Is wholly new plant necessary? | X | X | X | X | X | | | X |
| 2. What determines new plant location—transportation, labor, power, etc.? | | X | | X | X | | | X |
| 3. Can new product be made at some present plant? | | X | X | X | X | | | X |
| 4. Is additional land necessary? | | X | X | X | X | | | |
| 5. Does ideal ground plan fit into present operations? | | X | X | X | X | | | X |
| 6. What new buildings are necessary? | | X | | X | X | | | X |
| 7. Is it possible to install necessary shipping and other facilities? | | X | | X | X | | | X |
| 8. Will new facilities interfere with present operations? | | X | | X | X | | | X |
| 9. Are process and equipment recommendations from development department feasible for construction? | | X | | X | X | | | X |
| 10. What will completion of detailed plans and specifications cost? | | X | X | X | X | | | X |
| 11. What is preliminary estimate of new capital required? | X | X | X | X | X | | | X |
| 12. What rates of obsolescence and depreciation are anticipated on buildings? On equipment? | | X | X | X | X | | | X |
| 13. Can adequate safety provisions be made? | | X | | X | X | X | | X |
| 14. Are any unusual or difficult construction problems involved? | | X | | X | X | | | X |
| **VIII. PRODUCTION AND OPERATION PROBLEMS** | | | | | | | | |
| 1. Can present operating executives manage new enterprise? | | X | | X | X | | | X |
| 2. What new subordinate executives will be required? | | | | X | X | X | | X |
| 3. Will new type of operating experience or skill be required? | | | | | | | | |
| (a) Of executive staff? | | | | X | X | | | X |
| (b) Of foremen and workers? | | | | X | X | X | | X |
| 4. Are proposed plans and specifications satisfactory to operating executives? | | X | | X | X | X | | X |
| 5. Are all operating hazards adequately provided for? | | X | | X | X | X | | X |
| 6. How many additional employees will be needed of each class? | | X | X | X | X | | | X |
| 7. Are adequate labor reserves available at proposed point of production? | | X | | X | X | | | |
| 8. Are unusual labor troubles anticipated? | | X | | X | X | | | |
| 9. Can additional labor be found if production is increased? | | X | | X | X | | | |
| 10. What is effect of wage rate on cost of production? | | X | | X | X | | | X |
| 11. Can new product be coordinated seasonally with present plant activities? | | X | | X | X | | | X |
| 12. Are adequate provisions made for employee safety? | | X | | X | X | X | | X |
| 13. Will nuisances to neighbors be created; can they be controlled? | | X | | X | X | | | X |
| 14. Will plant operation be sufficiently flexible for adjustment to unexpected heavy demands? | | X | | X | X | | | X |
| 15. Can shut-downs be arranged where necessary during low demand seasons? | | X | | X | X | | | X |
| 16. Can repairs and maintenance be provided without interrupting plant operations? | | | | X | X | X | | X |
| 17. Are estimates of plant capacity reasonable? | | X | X | X | X | | | X |
| 18. Are spare parts and repair materials available? | | | | X | X | | | X |
| **IX. PACKAGING AND SHIPPING** | | | | | | | | |
| 1. What packages will be used for new product? | | | | X | | | | X |
| 2. Can standard packages be purchased? | | | | | | | | |
| 3. Must packages be of special material to resist damage by product? | | | | | | | | X |
| 4. Are needed package sizes known? | | | | | | | | |
| 5. Can proposed packages be shipped legally by all desired transportation agencies? | | | | | | | | X |
| 6. Will package damage in transit be serious? | | | | | | | | X |
| 7. Have legal labels been devised? | | | | | | | | X |
| 8. What are dealers' and consumers' desires as to package: Size, shape, etc.? | | | | | | | | X |
| 9. Will packages be returned for credit? | | | X | | | | | X |
| 10. What will reconditioning of packages cost? | | | X | | | | | X |
| 11. Are packaging machines or devices available? | | | | X | | | | X |
| 12. What is the cost of package ready for shipment? | | | X | | | | | X |
| 13. Will new product depreciate during storage: will depreciation be less in bulk or in packages? | | | | | | | X | X |
| 14. Will variety of packages required necessitate storage in bulk; or can storage be in ready-to-ship containers? | | | | X | | | | X |
| 15. What precautions are necessary for storage in bulk or in containers? | | | | X | X | | | X |
| 16. What space is required for storage of containers; new, returned, reclaimed? | | | | X | X | X | | |
| 17. Are adequate mechanical handling facilities provided for packaging and handling into and out of storage? | | | | X | X | X | | |
| 18. Are special loading facilities required for shipping? | | | | X | X | X | | |



(d) Wholesalers and jobbers?

(c) Home office sales force selling to all consumers?
(d) Wholesalers and jobbers?
(e) Manufacturers' agents?
(f) Combinations of above?
6. Will the new product go into the export field?
7. How will sales abroad be handled?
8. Will any channel of distribution be new to the company?
9. Will selling methods fit buying habits of the market?
10. Will selling methods fit into company's sales organization?

## VI. STUDIES OF COMPETITION

1. Who will be your competitors on new product?
2. What is the standing of each in the market?
3. What is the reputation of each for
   (a) Quality of product?
   (b) Market dominance?
   (c) Character of merchandise?
   (d) Dependability?
   (e) Service?
   (f) Progressiveness?
4. Will new product invite keener competition on present lines?
5. Will new product compete with those of any customer?
6. What in general will be effect of competitive activity on
   (a) Pricing?
   (b) Discounts and allowances?
   (c) Service?
   (d) Sales methods and organization?
   (e) Selling costs?
7. Can any competitor bring out a seriously competitive product?
8. If so, what steps should be taken to obtain quick distribution?
9. What will be effect on cost of sales and profits?

## VII. PRICING AND CREDIT POLICIES

1. What will be the general price policy on new product?
2. Does this fit into buying habits of markets?
3. How does it compare with competitors' policies?
4. What will be the schedule of discounts and allowances?
5. Do these fit into present buying habits of the market?
6. Will new credit facilities be needed by the manufacturer?
7. How much working capital will be tied up in credit?
8. Will the credit method require enlarged credit department?
9. Will present collection policy fit new product?
10. What is estimated cost of credit and collection per unit sale?
11. Does general price policy create higher selling cost?
12. Does general price policy create other sales handicaps?

## VIII. SALES AND SERVICING ORGANIZATION

1. Will special sales department be needed for new product?
2. Will technically trained salesmen be required?
3. Can company's present salesmen handle new product?
4. Will new product affect selling of regular line?
5. Will salesmen be needed for missionary and educational work?
6. What effect will sales organization changes have on
   (a) Sales costs?
   (b) Price of new product to customer?
   (c) Company profits?
7. What will be basis of salesmen's compensation?
8. Who will aid salesmen with research and territorial analyses?
9. Will new product need consultant or other sales service in use?
10. Will customer need special equipment for its use?
11. If so, who will supply?
12. If consultant service is rendered, will customer pay for it?
13. If not, how will service cost be absorbed?
14. Must service men have engineering training?
15. Will special engineering research be done to solve customers' problems?
16. Will plant engineers be available for outside consultation?
17. Can advertising be used to aid sales service?
18. How will service department costs be allocated?
19. How will they affect sales costs?

## IX. SALES PROMOTION

1. Will new products require special sales promotion set-up?
2. Will new advertising section or department be needed?
3. What type of advertising should be used for introductory campaign?
4. Will present advertising be related to new products?
5. Who will decide on media?
6. What will be the basis of sales promotion appeal?
7. Will technical publicity be required?
8. Will conventions, displays and expositions be used?
9. How budget S.P. program for new product:
   (a) Fixed amount as capital charge?
   (b) Arbitrary percentage of sales expectancy?
   (c) Fixed amount to be charged to first year's sales?
10. What will be effect of S.P. expense on sales costs?
11. What sales promotional work is done by competitors?
12. Will your S.P. program create retaliatory advertising by competitors?
13. Will it offend any part of your present market?

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(d) Wholesalers and jobbers?
(e) Manufacturers' agents?
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12. Does general price policy create other sal

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3. Can company's present salesmen handle
4. Will new product affect selling of regul
5. Will salesmen be needed for missionary
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8. Who will aid salesmen with research an
9. Will new product need consultant or othe
10. Will customer need special equipment for
11. If so, who will supply?
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19. How will they affect sales costs?

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ice policy on new product?
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ying habits of the market?
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ate other sales handicaps?

ANIZATION

be needed for new product?
smen be required?
men handle new product?
ing of regular line?
r missionary and educational work?
nization changes have on

customer?

en's compensation?
research and territorial analyses?
ltant or other sales service in use?
quipment for its use?

red, will customer pay for it?
be absorbed?
ering training?
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l sales service?
costs be allocated?
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cial sales promotion set-up?
or department be needed?
ould be used for introductory campaign?
related to new products?

ales promotion appeal?
uired?
d expositions be used?
r new product:
charge?
sales expectancy?
rged to first year's sales?
xpense on sales costs?
is done by competitors?
ate retaliatory advertising by competitors?
present market?

1. What will be the general price policy on new product?
2. Does this fit into buying habits of markets?
3. How does it compare with competitors' policies?
4. What will be the schedule of discounts and allowances?

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Is wholly new plant necessary? | | | | | | | | | | | |
| 2. What determines new plant location—transportation, labor, power, etc.? | | | | | | | | | | | |
| 3. Can new product be made at some present plant? | | X | X | X | X | | | X | X | X | X |
| 4. Is additional land necessary? | | X | X | X | X | | | | | | |
| 5. Does ideal ground plan fit into present operations? | | X | X | X | X | | | X | | | X |
| 6. What new buildings are necessary? | | X | | X | X | | | X | | | X |
| 7. Is it possible to install necessary shipping and other facilities? | | X | | X | X | | | X | | | X |
| 8. Will new facilities interfere with present operations? | | X | | X | X | | | X | | | X |
| 9. Are process and equipment recommendations from development department feasible for construction? | | X | | X | X | | | X | | | X |
| 10. What will completion of detailed plans and specifications cost? | | X | X | X | X | | | X | X | X | X |
| 11. What is preliminary estimate of new capital required? | X | X | X | X | X | | | X | | | X |
| 12. What rates of obsolescence and depreciation are anticipated on buildings? On equipment? | | X | X | X | X | | | X | | | X |
| 13. Can adequate safety provisions be made? | | X | | X | X | X | | X | X | X | X |
| 14. Are any unusual or difficult construction problems involved? | | X | | X | X | | | X | | | X |
| **VIII. PRODUCTION AND OPERATION PROBLEMS** | | | | | | | | | | | |
| 1. Can present operating executives manage new enterprise? | | X | | X | X | | | X | | | |
| 2. What new subordinate executives will be required? | | | | X | X | X | | X | | | |
| 3. Will new type of operating experience or skill be required? | | | | | | | | | | | |
| (a) Of executive staff? | | | | X | X | | | X | | | X |
| (b) Of foremen and workers? | | | | X | X | X | | X | | | X |
| 4. Are proposed plans and specifications satisfactory to operating executives? | | X | | X | X | X | | X | | | X |
| 5. Are all operating hazards adequately provided for? | | X | | X | X | X | | X | | | X |
| 6. How many additional employees will be needed of each class? | | X | X | X | X | | | X | | | X |
| 7. Are adequate labor reserves available at proposed point of production? | | X | | X | X | | | | | | |
| 8. Are unusual labor troubles anticipated? | | X | | X | X | | | | | | |
| 9. Can additional labor be found if production is increased? | | X | | X | X | | | | | | |
| 10. What is effect of wage rate on cost of production? | | X | | X | X | | | X | X | X | X |
| 11. Can new product be coordinated seasonally with present plant activities? | | X | | X | X | | | X | | | X |
| 12. Are adequate provisions made for employee safety? | | X | | X | X | X | | X | X | X | X |
| 13. Will nuisances to neighbors be created; can they be controlled? | | X | | X | X | | | X | X | X | X |
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| 15. Can shut-downs be arranged where necessary during low demand seasons? | | X | | X | X | | | X | | | X |
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| **IX. PACKAGING AND SHIPPING** | | | | | | | | | | | |
| 1. What packages will be used for new product? | | | | X | | | | X | | | |
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| 10. What will reconditioning of packages cost? | | | X | | | | | X | | | |
| 11. Are packaging machines or devices available? | | | | X | | | | X | X | X | |
| 12. What is the cost of package ready for shipment? | | | X | | | | | X | | | |
| 13. Will new product depreciate during storage: will depreciation be less in bulk or in packages? | | | | | | | X | X | | | |
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| 15. What precautions are necessary for storage in bulk or in containers? | | | | X | X | | | X | X | X | |
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| 17. Are adequate mechanical handling facilities provided for packaging and handling into and out of storage? | | | | X | X | X | | | | | |
| 18. Are special loading facilities required for shipping? | | | | X | X | X | | | | | |

**Chemical executives and engineers must rememb**
**reduce them to a minimum. In the final analysis**
**sound judgment and decisive action based on relial**

1. What will be the general price policy on new produ

2. Does this fit into buying habits of markets?

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**emember that the solution of all of these problems listed here will not eliminate all mistakes b**
**nalysis the successful development and profitable marketing of a new product will depend on**
**n reliable facts and figures—rather than on executive's hunch, salesman's intuition or academi**

| |
|---|
| (d) Sales methods and organization? |
| (e) Selling costs? |
| 7. Can any competitor bring out a seriously competit |
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**ment and profitable marketing of a**
**ather than on executive's hunch, sal**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | | | | | | | | | | | | X | X | X | X | | | | |
| | | X | X | | | | | | | | | | | X | X | X | X | | | | |
| usly competitive product? | | | | | | | | X | X | X | | | | X | X | X | X | | | | |
| btain quick distribution? | | | | | | | | | | | | | | X | X | X | X | X | | | |
| nd profits? | | X | X | | | | | | | | | | | X | X | X | X | X | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| on new product? | | X | X | | | | | | | | | | | X | | | X | | | | |
| markets? | | | X | | | | | | | | | | | X | X | X | X | | | | X |
| s' policies? | | | X | | | | | | | | | | | X | X | X | X | | | | |
| s and allowances? | | | X | | | | | | | | | | | X | X | X | X | | | | |
| s of the market? | | | X | | | | | | | | | | | X | X | X | X | | | | |
| y the manufacturer? | | X | X | | | | | | | | | | | X | | | X | | | | |
| d up in credit? | X | X | X | | | | | | | | | | | X | | | X | | | | |
| d credit department? | | X | X | | | | | | | | | | | X | | | X | | | | |
| product? | | X | X | | | | | | | | | | | X | | | X | | | | |
| collection per unit sale? | | X | X | | | | | | | | | | | X | X | X | X | | | | |
| er selling cost? | | X | X | | | | | | | | | | | X | | | | | | | |
| sales handicaps? | | X | X | | | | | | | | | | | X | | | | | | | |
| ON | | | | | | | | | | | | | | | | | | | | | |
| ed for new product? | | X | | | | | | | | | | | | X | X | X | X | | | | |
| required? | | X | | | | | | X | X | | | | | X | X | X | X | | | | |
| dle new product? | | X | | | | | | | | | | | | X | X | X | X | | | | |
| gular line? | | X | | | | | | | | | | | | X | X | X | X | X | | | |
| ary and educational work? | | X | | | | | | | | | | | | X | | | X | | | | |
| hanges have on | | | | | | | | | | | | | | | | | | | | | |
| | | X | X | | | | | | | | | | | X | | | X | | | | |
| ? | | X | X | | | | | | | | | | | X | | | X | | | | |
| | X | X | X | | | | | | | | | | | X | X | X | X | | | | |
| pensation? | | X | X | | | | | | | | | | | X | | | | | | | |
| and territorial analyses? | | | | | | | | X | | | | | | X | | | X | | | | |
| ther sales service in use? | | X | | X | | | | | | | | | | X | X | X | X | | | | |
| for its use? | | X | | X | | | | X | | | X | | | X | X | X | X | | | | |
| | | X | | | | | | | | | | | | X | | X | X | | | | |
| customer pay for it? | | X | | | | | | | | | | | | X | | X | X | | | | |
| ed? | | X | | | | | | | | | | | | X | | X | X | | | | |
| ning? | | X | | X | | | | X | X | X | X | | | X | | X | X | | | | |
| one to solve customers' problems? | | X | | | | X | | X | X | | | | | X | | X | X | | | | |
| outside consultation? | | X | | X | X | X | | | | | | | | X | | X | X | | | | |
| vice? | | | | | | | | | | | | | | X | | | X | X | | | |
| allocated? | | | X | | | | | | | | | | | X | | X | X | | | | |
| | | X | X | | | | | | | | | | | X | | X | X | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| promotion set-up? | | X | X | | | | | | | | | | | X | X | X | X | X | | | |
| ment be needed? | | X | | | | | | | | | | | | X | X | X | X | X | | | |
| sed for introductory campaign? | | X | | | | | | | | | | | | X | X | X | X | X | | | |
| new products? | | X | | | | | | X | | | | | | X | X | X | X | X | | | |
| | | X | | | | | | | | | | | | X | X | X | X | X | | | |
| otion appeal? | | X | | | | | | X | | | | | | X | X | X | X | X | | | |
| | | X | | | | | | X | | | | | | X | | | X | X | | | |
| ons be used? | | X | | | | | | | | | | | | X | | | X | X | | | |
| duct: | | | | | | | | | | | | | | | | | | | | | |
| | | | X | | | | | | | | | | | X | | | X | X | | | |
| ectancy? | | | X | | | | | | | | | | | X | | | X | X | | | |
| rst year's sales? | | | X | | | | | | | | | | | X | | | X | X | | | |
| sales costs? | | X | X | | | | | | | | | | | X | | | X | X | | | |
| by competitors? | | X | | | | | | | | | | | | X | X | X | X | X | | | |
| atory advertising by competitors? | | X | | | | | | | | | | | | X | X | X | X | X | | | |
| market? | | X | | | | | | | | | | | | X | X | X | X | X | | | |

**ere will not eliminate all mistakes but should**
**g of a new product will depend on the use of**
**ch, salesman's intuition or academic research**